Iron and Steel Engineer

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JOHN F. KELLY, EDITOR

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ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS

EXTEND A CORDIAL INVITATION

TO ATTEND ITS

29th CONVENTION

AND

IRON AND STEEL EXPOSITION

OCTOBER 17–18–19, 1933

WILLIAM PENN HOTEL

PITTSBURGH

TECHNICAL SESSIONS 9:30 A. M.

Electrical Engineering Division

Combustion Engineering Division

Lubrication Engineering Division

Mechanical Engineering Division

Safety Engineering Division

EXPOSITION HOURS

Tuesday	1:30 to 5:30 P. M	Evening 7:00 to 10:00 P. M.
Wednesday	9:00 A. M. to 5:30 P. M.	Evening 7:00 to 10:00 P. M.
Thursday	10:00 A. M. to 10:00 P. M.	

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THURSDAY EVENING FORMAL RECEPTION

and

A. I. & S. E. E. "NEW USES FOR STEEL CAMPAIGN" PRIZE PRESENTATIONS

W. E. MILLER, Chairman

A. J. Standing, R. M. Hussey, W. T. Snyder, Wray Dudley, G. R. McDermott, J. M. Kelly, G. E. Stoltz, A. E. Gibson, K. F. Treschow, H. J. Fisher, F. Waldorf, A. C. Dyer, T. J. Flaherty, H. G. R. Bennett, W. Spellmire, J. H. Hunter, R. L. Kirk, B. R. Shover, Karl H. Runkle, R. O. Watson, Jos. McKinley, N. C. Bye, A. Kuhns, S. H. McKee, A. N. Cartwright, J. J. Bangert, J. L. Young, H. F. Brenholts, H. G. Gibson, K. Feller

Mr. I. Lamont Hughes, President of Carnegie Steel Co., Pittsburgh, Pa., extends a cordial welcome to the membership of the A. I. & S. E. E. to visit Pittsburgh during the 29th Convention.

Carnegie Steel Company
SUBSIDIARY OF UNITED STATES STEEL CORPORATION
General Offices: Carnegie Building
Pittsburgh, Pa.

I. LAMONT HUGHES,
PRESIDENT.

October 1, 1933.

Association of Iron & Steel Electrical Engineers,
1010 Empire Building,
Pittsburgh, Pennsylvania.

Gentlemen:-

As a representative of the Iron and Steel Industry in this district, I take great pleasure in extending to you a cordial and hearty welcome to Pittsburgh, as you assemble here on the occasion of your Twenty-Ninth Annual Convention.

In view of Pittsburgh's eminent position as one of the greatest industrial centers of all time, it is most fitting and proper that your Convention be held here,- the pioneer Iron and Steel center of the world. No one, whose life's work has been devoted to the advancement of the greatest industry of this great producing and manufacturing district, could fail to recognize and appreciate the prominent part in our industrial development that has been played by the members of the engineering profession; and it is particularly because of our complete realization of the important and ever increasing contribution of the members of your Association to Pittsburgh's advancement and greatness that we hasten to give expression to our deep sense of pleasure in welcoming you once more to this City - the center of a district in which so many of the successful fruits of our joint efforts and labors are in evidence.

In addressing you, it is not necessary to dwell more lengthily upon Pittsburgh's contribution to the industrial growth and wealth and happiness of the people of this entire Nation; but it is indeed becoming that executives and operators of our manufacturing facilities be ever mindful of the indispensable assistance which has been rendered by the members of your honorable profession. That you are not willing, however, to be satisfied with the achievements and accomplishments of the past needs no expression, and the whole-hearted desire and purpose of your Association to stimulate its members toward still greater achievement is fully attested to by the scope and significance of the matters to be treated and discussed as a part of the activities of your Convention.

May this Convention, with its wonderful opportunities for close communion of minds similarly employed, and for exchange and dissemination of ideas and views, serve to stimulate and encourage us all to greater endeavors. It is our earnest hope that the hours spent with us in Pittsburgh will be happy and fruitful ones, in which we may all participate in that spirit of fellowship, good will, and mutual appreciation so necessary if we are to best serve our purpose as co-workers, co-operating for the common good.

In such a spirit we welcome you to tarry for a while among us.

Yours sincerely,

I Lamont Hughes

President.

TUESDAY, OCTOBER 17th, 1933

9:00 A. M.—Registration, Technical Sessions: Chairman, C. A. Thayer, Chief Engr., Republic Steel Corp., Youngstown, Ohio.

9:15 A. M.—Business Session, Urban Room, 17th Floor, Chairman, W. E. Miller, President, A. I. & S. E. E., and Electrical and Mechanical Superintendent, Bethlehem Steel Co., Johnstown, Pa. Secretary, A. D. Adams, Asst. Supt., Spang Chalfant & Co., Inc., Ambridge, Pa.

MECHANICAL, ELECTRICAL AND LUBRICATION DIVISIONS

Technical Sessions, Urban Room, 17th Floor, Chairman, W. E. Miller, Elec. and Mech. Supt., Bethlehem Steel Co., Johnstown, Pa. Secretary, A. D. Adams, Asst. Supt., Spang Chalfant & Co., Inc., Ambridge, Pa.

9:30 A. M.—"Developments in the Iron and Steel Industry" by W. H. Burr, Elec. and Mech. Supt., Lukens Steel Co., Coatesville, Pa.

Chairman, C. A. Kral, Supt. of Blooming Mill, Bar and Hot Strip Mills, Wheeling Steel Corp., Steubenville, Ohio. Secretary, J. W. Bates, Elec. Engr., Power Div., American Sheet & Tin Plate Co., Pittsburgh, Pa.

10:15 A. M.—"A Review of Cold Mill Practices—Sheet, Tin and Strip," by Stephen Badlam, Consulting Engineer, Pittsburgh, Pa.

Chairman, G. R. Carroll, Elec. Supt., Jones & Laughlin Steel Corp., Aliquippa, Pa. Secretary, H. G. Gibson, Chief Engr., McKeesport Tin Plate Co., McKeesport, Pa.

1:30 P. M.—"Electrical Features of Modern Cold Roll Strip Mills," by A. F. Kenyon, General Engr., Westinghouse Elec. & Mfg. Company, East Pittsburgh, Pa.

2:30 P. M.—"Recent Developments in Electrical Equipment of Cold Strip Mills of Various Types," by F. Mohler, Industrial Engineering Department, General Electric Company, Schenectady, N. Y.

3:30 P. M.—"Controlling Screwdown Drafts to the Exact Specifications of the Mill Superintendent," by D. C. Wright, Chief Engr., Electric Controller & Mfg. Co., Cleveland, Ohio.

WEDNESDAY, OCTOBER 18th, 1933

MECHANICAL, ELECTRICAL AND LUBRICATION DIVISIONS

Technical Sessions, Urban Room, 17th Floor, Chairman, B. R. Shover, Consulting Engineer, Pittsburgh, Pa. Secretary, R. E. Lewis, Elec. Supt., Youngstown Sheet & Tube Co., Youngstown, Ohio.

OFFICIAL

CONVENTION AND IRON

AUS

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OCTOBER 17,

WILLIAM PENN HOTEL

9:30 A. M.—"Anti-Friction Bearings in Connection with Cold Mills," by F. C. Hallmark, Gen. Master Mech., Wheeling Steel Corp., Steubenville, Ohio. C. J. Klein, Chief Engr., Weirton Steel Co., Weirton, W. Va.

Chairman, C. C. Pecu, Lubrication Engr., Bethlehem Steel Co., Lackawanna, N. Y. Secretary, S. H. McKee, Consulting Engineer, Youngstown, Ohio.

10:00 A. M.—"Mechanical, Lubrication and Electrical Problems in Connection with Reduction Gear Sets of Main Drive Mill Motors," by T. Holloway, Gear Consultant, United Engineering & Foundry Co., Pittsburgh, Pa. Austin Kuhns, Engineer, Farrel-Birmingham Co., Inc., Buffalo, N. Y.

12:30 P. M.—Inspection Trip—by Special Chartered Buses Only.
Allegheny Steel Co., at Brackenridge, Pa.
American Sheet & Tin Plate Co. at Vandergrift, Pa.
Transportation Tickets for this trip on sale at Registration Booth, Main Lobby, William Penn Hotel.

MEMBERS, GUESTS AND EXHIBITORS INVITED

THURSDAY, OCTOBER 19th, 1933

WELDING ENGINEERING DIVISION

Technical Sessions, Urban Room, 17th Floor. Chairman, G. A. Hughes, Elec. Engr., Truscon Steel Company, Youngstown, Ohio. Secretary, J. A. Morgan, Asst. Supt., Maintenance Dept., Carnegie Steel Co., Braddock, Pa.

9:30 A. M.—"Welding Practices in the Iron and Steel Industry in Connection with Arc Welding Equipment, Automatic Arc Welding, Electrodes, Operators, Carbon Arc Welders, Resistance Welding, Atomic Hydrogen Welding, Acetylene Welding and Thermit Welding" (Information and Data furnished through a Questionnaire by the Iron and Steel Industry.)

PROGRAM

AND STEEL EXPOSITION

PICES

STEEL ELECTRICAL ENGINEERS

18, 19, 1933

- PITTSBURGH, PA.

10:00 A. M.—"Growth of the Electric Arc Welding Industry," by E. A. Hurme, Engineer, Clark Controller Co., Cleveland, Ohio.

10:30 A. M.—The Part Welding Will Play in Metal Houses," by Bennett Chapple. Vice Pres., American Rolling Mill Co., Middletown, Ohio.

11:00 A. M.—"Welded Rolled Steel Products," by F. L. Lindemuth, Chief Engr., Wm. B. Pollock Co., Youngstown, Ohio.

1:30 P. M.—"Advantages of Welded Design with Reference to Weight, Strength, Time and Costs," by A. E. Gibson, Vice Pres., Wellman Engineering Co., Cleveland, Ohio.

2:00 P. M.—"Advantages to Be Secured Through Welding in Mill Building," by Lloyd Jones.

2:30 P. M.—"Rolled Steel Products and Arc Welding in the Fabrication of Electric Locomotives," by R. V. Devlin, Industrial Locomotive Division, General Electric Co., Erie, Pa.

3:00 P. M.—"Comparison of Welding with Riveting and Bolting for Steel-Building Connections," by Gilbert D. Fish, Consulting Structural Engineer, Westinghouse Elec. & Mfg. Company, New York, N. Y.

THURSDAY, OCTOBER 19th, 1933

COMBUSTION ENGINEERING DIVISION

Technical Sessions, Cardinal Room, 17th Floor. Chairman, F. E. Leahy, Fuel Engr., Youngstown Sheet & Tube Co., Youngstown, Ohio. Secretary, J. L. Miller, Steam Engr., Carnegie Steel Co., Youngstown, Ohio.

9:30 A. M.—"Fundamentals of Open Hearth Design," by W. C. Buell, Jr., Engineer, Cleveland, Ohio.

10:00 A. M.—"Recent Developments in Design and Operation of Industrial Furnaces," by G. A. Merkt, Engr., Combustion Control Department, Morgan Construction Co., Worcester, Mass.

10:30 A. M.—"Heating Slabs for Hot Strip Mills," by W. R. Culbertson, Mgr., Furnace Div., Rust Engineering Co., Pittsburgh, Pa.

1:30 P. M.—"Pack and Pair Heating Furnaces in Connection with Sheet and Tin Mills," by R. J. Wean, President, Wean Engineering Company, Warren, Ohio.

2:00 P. M.—"Electric Furnaces for Annealing Strip and Sheets," by A. N. Otis, Industrial Engineering Department, General Electric Co., Schenectady, N. Y.

9:00 P. M.—Formal Reception, Urban Room.

General Chairman, W. E. Miller, Electrical and Mechanical Superintendent, Bethlehem Steel Company, Johnstown, Pa.

10:00 P. M.—Awarding of Prizes "New Uses for Steel Campaign."

IRON AND STEEL EXPOSITION

As in previous years, the Iron and Steel Exposition will be one of the features of the Annual Convention. The object of the Iron and Steel Exposition is to acquaint engineers with the status of the art in reference to the various lines of apparatus used in the Industry. Accomplishments by the use of improved devices, new applications, etc., will largely form the subjects of the papers and discussions at the technical sessions. Technical papers and discussions regarding the improvement of the quality of product and economy of operation develop the urge to make improvements. Exhibits and Expositions develop this urge into a real desire as concrete suggestions and ideas are presented in these equipment displays.

In the Iron and Steel Exposition each year, the manufacturers who service the Iron and Steel Industry are presented an opportunity to display or exhibit the new developments in their products and equipment to the engineers and executives of the Iron and Steel and allied Industries. It is at the Exposition that the engineers and executives have the opportunity to inspect, examine and have demonstrated to them just what the equipment will do for them in their plants..

EXPOSITION HOURS

(Opens) Tuesday, 1:30 to 5:30 P. M. Evening, 7:00 to 10:00 P. M.

Wednesday, 9:00 A. M. to 5:30 P. M. Evening, 7:00 to 10:00 P. M.

Thursday, 10:00 A. M. to 10:00 P. M. (Closes.)

Mr. W. E. Miller, Electrical and Mechanical Superintendent, Bethlehem Steel Company, Johnstown, Pa., President of the Association of Iron and Steel Electrical Engineers for the year 1933-1934.

A. I. & S. E. E. Convention and Exposition

By W. E. MILLER,
President, Association of Iron and Steel Electrical Engineers.

On October 17, 18 and 19 the Association of Iron & Steel Electrical Engineers will convene at the William Penn Hotel in Pittsburgh, Pa. This meeting will be the twenty-ninth convention of the society. As president of your society, I cannot do too much to impress upon you the importance of this annual meeting. There is no need at this time to mention what our industry has been subjected to in the past few years. However, I can, with pride, mention the part the association has played in these past trying years. Instead of slackening up on the effort to carry out the preamble of the society (the sponsoring of all engineering developments to the manufacture of iron and steel) these handicaps only provided an incentive to prove that the association is a vital economic factor in the industry.

We all realize that it is true of every function of business, government and even of the business of living itself, to progress we must have co-operation. The founders of our society recognized this fact twenty-seven years ago. These farsighted men visualized the problems which would confront the engineers of the iron and steel industry in the future. To these men we owe a debt of gratitude. We can help pay this debt by giving of ourselves as unstintedly as they, both our talent and service. I have no doubt that with such a wonderful record behind us and with the co-operative efforts of all the members this coming convention will be attended with success.

With the statement of these facts I earnestly solicit your help in maintaining the high standards set by our predecessors. The program which has been arranged for this coming meeting is one to interest every one associated with the iron and steel industry. In the following subjects one can gleam that our program is of a broad nature:

Developments in the Iron and Steel Industry

Electrical Features of Modern Cold Roll Strip Mills

Controlling Screwdown Drafts to the Exact Specifications of the Mill Superintendent

Review of Cold Mill Practices — Sheet, Tin and Strip

Recent Developments in Cold Strip Mill Electrical Equipment.

Anti-Friction Bearings in Connection with Cold Mills

Mechanical, Electrical and Lubrication Problems in Connection with Reduction Gear Sets of Main Drive Mill Motors

Growth of the Electric Arc Welding Industry

The Part Welding Will Play in Metal Houses

Welded Rolled Steel Products

Advantages to be Secured Through Welding in Mill Building

Comparison of Welding with Riveting and Bolting for Steel-Building Connections.

Fundamentals of Open Hearth Design

Heating Slabs for Hot Strip Mills

Pair and Pack Heating Furnaces in Connection with Sheet and Tin Mills.

Welding Practices in the Iron and Steel Industry in Connection with Arc Welding Equipment, Automatic Arc Welding, Electrodes, Operators, Carbon Arc Welders, Resistance Welding, Atomic Hydrogen Welding, Acetylene Welding and Thermit Welding

Advantages of Welded Design with Reference to Weight, Strength, Time and Costs

Rolled Steel Products and Arc Welding in the Fabrication of Electric Locomotives

Recent Developments in Design and Operation of Industrial Furnaces

Electric Furnaces for Annealing Strip and Sheets

Along with our technical sessions there will be the iron and steel exposition to help educate the engineer in new methods and means of manufacture. Inspection trips will be made to the modern plants of the Allegheny Steel Company and the American Sheet & Tin Plate Company which companies have graciously permitted us the opportunity to view their installations. In closing I extend to all a cordial invitation to attend our twenty-ninth convention and iron and steel exposition.

Which Phase of Steel-making Process is Most Responsible for The Quality of Steel Products?

By FEODORE F. FOSS,
Assistant to Chairman & General Metallurgist, Wheeling Steel Corporation,
Wheeling, W. Va.

▲

If arithmetic, mensuration and weighing be taken away from any art, that which remains will not be much.—Plato.

Our Association's management has invited me to express my opinion on "the part improved rolling mill practice will play in the future to produce high quality steel products."

Remarks in the same letter—referring to the possibilities of steel quality improvement by the application of scientific investigations to the rolling mill practice, just as it has been done during recent years with the studies of the open hearth process—give me an opportunity to express my views on the subject of steel quality and particularly on the problem, whereto and how have we to look to improve this quality.

Having on his hands such a vexatious subject as a problem of quality of a product, one is bound to be very careful in his definitions, knowing, of course, that a definition is a purely arbitrary thing. The first step, however, in a systematic treatment of any subject as a matter of expediency is to make the definition of the term under discussion.

We know, that the word "quality" is used in our daily life, as well as in special literature, rather loosely, covering a wide range of meanings. We speak about quality of a character and manners, quality of food, quality of a picture and quality of cloth. Very often under the conception of quality, the "properties" of a product are meant and conception of "properties," in its turn, is mixed with the conception of "grades".

We speak about welding or stamping qualities of steel and, at the same time, we say "high quality" alloy steel, meaning that the properties of alloy steel are higher than the properties of common steel. Sometimes, usually in advertisements, we run across a very strong expression like "high grade properties of quality steel."

FEODORE F. FOSS

There is nothing new in these facts and many efforts have been made by technical and scientific societies and institutions to disseminate right conceptions on different properties of steel, but the results of these efforts have not yet been felt.

Some time ago there was a movement to classify the steel products according to their grades and properties by working out a systematic "quality figure" for every grade and property. Formulae have been devised—in which elastic limit, reduction of area and dynamic figure, representing fatigue-resisting property, entered. These "quality figures" have been met with limited success, however, for evident reasons, as many characteristics of steel products cannot be formulated in a simple expression.

It is not my intention, at this time, to go into philology and philosophy of the conception of quality, as it is extremely difficult thing, particularly in connection with steel products, but I wish to make it clear, that, under the conception of "quality of a product," I understand here the **degree of regularity with which the properties of every piece of certain product answer the prescribed specification.**

Systematic investigation of steel products and long-time observations of steel-making processes show, that the quality of steel (understood in the above way) depends on the regularity with which all necessary properties of steel have been imparted to it during its origination and forming, that is, during the making of steel out of raw materials, during its heat and mechanical treatment.

The process of steel-making, which by smelting pig iron from raw materials and further oxidation of it in the steel furnaces actually creates the physical and chemical composition of steel, naturally imparts to the steel the largest number of properties. The heat treatment can modify these properties to a great extent, but the range of variations in this process is smaller than in smelting and melting. The influence of mechanical treatment on the prop-

erties of metal is still smaller than that of heat treatment.

All processes, which steel undergoes in its making, treatment and shaping, are the results of natural forces and as such are governed by laws of chemistry and physics. Therefore, it is logical to take the underlying laws as a basis for an evaluation of the importance of different processes on steel properties. The difficulty, however, which we encounter from the start lies in the fact, that, altho many natural laws are perfectly understood and successfully applied to the technological problems, a good part of other laws is not yet completely defined and, therefore, the phenomena governed by these laws cannot be satisfactorily explained.

When a stone is thrown up and is left to the law of gravitation to govern it, we are able to foretell exactly when, where and how this stone is going to land. Basing on the kinetics of solid bodies, we can determine with a great degree of accuracy the trajectory a projectile sent by a gun will make. In dealing with atoms, electrons and quanta of gases or molten substances in a furnace, however, we are not yet able to foretell exactly and in each and every instance, in which specific direction a small particle contained in the gas or molten material is going to go.

This illustration is made to show, that the degree of applicability of the laws of chemistry, physics and thermo-dynamics to the phenomena occurring in the processes of steel-making might be rather limited in some instances.

That is the reason, why, up to the present time, we have so many "mysteries" connected with the making of steel and with the explanation of failures of steel products.

Mr. H. W. Graham, discussing quality of steel in his paper—"A modern conception of steel quality" (A. I. & S. I.—May, 1932), speaks on the inadequacy of existing metallurgical knowledge and, in quoting Professor Howe, uses an expression "two mysterious cases." It is interesting to mention, by the way, that, in this paper, Mr. H. W. Graham clearly points out for the first time in the technical literature the dependence of all steel properties on the conditions in which steel was originated.

Many "mysteries" of iron technology are known to metallurgical men and several of these mysteries have been mentioned in the literature. Some iron products have already passed into history, leaving behind stories on wonderful properties of metals. We know of iron columns, which, being exposed to the atmosphere, did not rust for centuries, of iron-roofs standing without protective coatings for many decades and we know of the damascene steel swords possessing unusual physical properties. We know of castings made out of charcoal pig, which have shown high tensile strength and considerable elongation. When such charcoal pig was produced from a slow traveling charge in a blast furnace with cold wind and converted afterwards into rolls, these rolls gave tremendous tonnage of sheets without breakage and wear. It is a well-known fact, that much larger reductions in rolling can be applied to the steel made out of charcoal pig iron. Cast iron bar—⅛" thick—?" wide—made out of high phosphorous charcoal pig and bent into a circle has been described somewhere in the literature and the piece existed in the museum.

It is quite possible, that some of these "mysteries," if investigated under the light of present day science, could be explained in some way or another, but we must confess, that several phenomena, not well understood in the olden days, are not much clearer to us now.

Together with the "mysteries," the history of steel producing art gives us examples of "superstitions," which have been particularly connected with the "quality" of steel. Men, long time in the steel industry, can remember the special "qualities" the "hammered" or "forged" steel has been promised to possess. It was claimed, that forged steel was superior to the rolled product. Then came the era of forging of steel under hydraulic presses and this product was presented as superior to all other steel. Ultimately came cast steel, thermally treated, which has successfully competed with forged and rolled material. This fact has demonstrated, that claims of hammered or hydraulically forged steel for superiority have been without solid foundation.

By and by, most of these superstitions on the quality of steel disappeared mainly under the pressure of sound economics, with the developments of proper testing facilities and systematic application of metallurgical science to the practice of steel-making.

The study of the history of science and of its application to the industry teaches us, that certain sequence in every development can be observed, phenomena of less complicated nature having been studied earlier and the matter of higher order having been explained only when science became of age.

The process of forming metal by rolling is the oldest of all methods used nowadays in the art of steel-making. Leonardo da Vinci has designed a bar rolling mill in about 1495. In 1784 Cort has developed a mill to roll the product of the puddling furnace. Only in 1870, when Saint-Venant has published his differential equations on plastic dynamics, the application of the science to the rolling mill practice has been started. H. Tresca, with his paper on the flow of metals, published in 1865, should be, possibly, mentioned first, but his study referred mostly to the general plasticity of solid bodies, than to the theory of rolling.

C. Fink, in 1874, and particularly E. Blass in 1881, have created a theory of rolling process, which, in general, is used at the present time, being supplemented, of course, by the studies of several prominent scientists and metallurgical specialists, like Denis, Codron, Urben, Geuze, Hollenberg, Brovot and others.

There have been many experiments in rolling of metal made by several ingenious investigators (J. Puppe and particularly N. Metz), but the prevailing theory of rolling, as used by the practice, has not been considerably changed by the results of these experiments.

Many new ideas on the "spread," on the "slippage cones and prisms" and on the influence of "stiff end" on the condition of rolling have been advanced. An application of hydro-dynamical theory to the phenomena during rolling of metals was made,

but it did not bring any marked improvements into the practice of rolling.

The general study of plasticity of metals in the last decade has made great strides and the work of many brilliant investigators, as H. Henky, L. Prandle, E. Siebel, A. Nadai and many others, has contributed toward the elucidation of plastic deformation of metals so much, that phenomena of metal flow during rolling process are much better understood.

It is clear, however, that these and future achievements of the science of flow of metal, as far as it is studied under the angle of application of mechanical forces, hardly will result in any revolutionary changes of the rolling practice.

A survey of the results science produced on the heat treatment of metals connected with the studies of crystalline structure, gives a picture of continuous penetration of inquisitive minds into the depths of the unknown. It reveals such a tremendous amount of study and such a long list of achievements, that a good-sized book would be needed for only cataloging the names of investigators and the results of their work.

In the period of practically one generation, since Tschernoff's discovery of the points of recalescence (1868), up to the time of our illustrious contemporary, A. Sauveur, a complete science of heat treatment of steel was created. This has indicated, that there was a field for application of science to this branch of steel technology and the results of such application have been prolific.

The application of science to the processes of steel-making out of pig iron has begun, so to speak, only yesterday. Until recently, all of us have regarded the book of Carl Dichmann, published in 1909, and the H. H. Campbell's Manufacture & Properties of Iron & Steel, 1896, as a foundation of steel-making studies. Several brilliant scientists, most of them our contemporaries, who have attacked the problems connected with steel-making processes, have revealed, in their first steps, that, here we are confronted with a vast and deep sea of ignorance and that the facilities presented by the science to navigate this sea are, in many instances, limited. Notwithstanding this, many keen minds have set the sail with a result, that, in a few years, light-beacons in some of the most dangerous points have been placed. It seems to me, that several scientists, more suitably equipped for the purpose, succeeded to erect many powerful light-houses, which help us to prick the chart of our navigation with more certainty.

In this case, again, we have an example of wonderful strides made by the application of science to the practical art in a very short period (from C. Dichmann in 1909 to Dr. Herty, Jr. in 1930), at the end of which, a new page in the book of iron metallurgy was turned.

It will take time to get complete understanding of all complicated physical and chemical laws governing the steel-making, but, once started, it will be done in a shorter time than it took to develop rolling process, infinitely simpler than the "steel-making." If the phenomena of rolling process (mechanical and thermal forces) can be visualized as two-dimensional expression and heat treatment with the thermal, physico-chemical forces and time as a three-dimensional expression, the steel-making should be imagined like a four-dimensional expression, as besides the above mentioned forces and time the influence of space has to be taken into consideration.

And, when the steel-making furnaces and practical operations will be coordinated with the requirements of the science, we believe, that the fundamentals recently brought into the steel metallurgy will give an answer to the question "where do we have to look for the quality of steel."

The conclusion, that the "pedigree" of steel product is written by the steel-maker and that the improvements in steel quality are bound to come first of all from the studies of steel-making processes, does not exclude the necessity of watching all other phases of steel production.

To safeguard the present level of quality of steel products and to make further improvements, the attention paid to rolling and heat treatment should be intensified in the same proportion as it is expected to be given to the steel-making process. The sight should not be lost of the fact, that, altho few new properties can be imparted to the steel by heat and mechanical treatment, these processes, not properly applied, can easily deprive steel of its quality. Well-made steel can be spoiled by further poor treatment.

Operating men perfectly know that and do not stand in expectation for some scientific investigation bringing them a new schedule of easy travel to success. They do their own thinking and observation.

The observation of daily operations and their results, however, should be treated, nowadays, in a different way than before. New, fast-developing science of technological statistics, based on the frequency distribution and on the theory of probability (in Germany there is a short word—Grosszahlforshung—coined for this purpose), should be introduced in every case, when profitable results from the daily observations are expected.

Every steel producer, who wants to make **quality steel** consistently **at a lowest possible cost,** should have statistical supervision of all phases of his production and continuously improve the quality of steel and regulate the costs as results of such supervision.

The foundation for the future is the experience of the past.

J. A. CLAUSS
Chairman, Iron and Steel Exposition Committee

BARTON R. SHOVER
Chairman, Technical Session, Wednesday, October 18

C. A. THAYER
Chairman, Technical Sessions Registration

Prominent Steel Mill Engineers, who will be active at the A. I. & S. E. E. Convention and Iron and Steel Exposition at Pittsburgh, Pa, October 17, 18, 19, 1933.

A. D. ADAMS
Chairman, Committee on Attendance

F. E. LEAHY
General Chairman, Combustion Engineering Sessions, Thursday, October 19th

C. C. PECU
Chairman, Lubrication Engineering Division

The Future of The Iron and Steel Engineer

By GEORGE M. VERITY
Chairman, The American Rolling Mill Co., Middletown, Ohio

The Association of Iron and Steel Electrical Engineers has invited me to prepare an editorial concerning the future of the steel mill engineer which opens up a large and new field of thought and one which no doubt applies fully as much to other fields of effort. In other words, how are we going to successfully adapt ourselves to the radically new conditions which exist.

For many years past and up to the recently lamented depression, the engineering departments of our steel mills were being completely absorbed in the development of new facilities.

The engineer himself had been so busily engaged in that class of work that he did not have the time to undertake other responsibilities in connection with the business which by education and training he was competent to handle. Due to this concentration of effort both the managements and operating personnels of many companies have come to believe that that was the one and only service that the steel mill engineer could properly render. Furthermore, due to the fact that the work in which the engineer was engaged was so extremely interesting to him, very few of them sought the opportunity for development along broader lines.

With the advent of the N.R.A. a broadening of the responsibilities and objectives of the steel mill engineer might prove very helpful. It is therefore important that he should realize this fact and prepare himself for this new opportunity.

Under the new order of things better control of production will become a serious and outstanding problem and, as a consequence, much less emphasis will be placed on the development of new facilities or of labor saving devices.

The elimination of all unfair practices in the conduct of Industry will result in placing a much greater emphasis on Quality, as that is a factor on which the Recovery Act places no restrictions.

By education and training the competent engineer has the knowledge and ability which enables him to analyze figures and facts. He should now direct that ability more largely towards the problems of production and efficient management.

He should familiarize himself to a much greater extent with the details of operating practice so that he can more effectively contribute his part to the better utilization of raw materials and supplies, and to the better adaptation of existing facilities to the production of a product of superior quality at a minimum cost.

That sort of work will be necessary to offset the added increase in cost of many of the items which will now enter into the total cost of a product.

The engineer has been trained to think in terms of and to effectively apply materials and equipment. In the past the problems of supervision were largely a matter of men and materials; today they have become complicated by the installation of intricate and expensive equipment. The continued progress of Industry will therefore depend, to a very great extent, on its ability to make continued advancement in the efficient utilization of materials and equipment. This is particularly true because the N.R.A. does impose many restrictions on the efficient utilization of personnel.

There are many good designers available, but all too often men who have devoted the necessary time and effort to their development as good designers have no training as competent investigators.

There are many obstacles in the way of developing competent engineers along these broader lines. The hearty assistance of management will therefore be necessary if such a development is to be realized.

American Sheet & Tin Plate Company—Vandergrift Works

By JULIUS GRAF
Chief Engineer, American Sheet & Tin Plate Company, Pittsburgh, Pa.

In welcoming the Association of Iron and Steel Electrical Engineers, who are to be our guests on October 18, the author feels that it is only fitting at this time to give a short history of the Vandergrift Works of the American Sheet and Tin Plate Company which is located at Vandergrift, Pa., approximately 38 miles from Pittsburgh, on the Kiskiminetas River, in close proximity to coal and natural gas fields. The plant was built during the years 1895 to 1898. At that time the Works consisted of six 30-ton open hearth furnaces, a reversing blooming mill, a continuous bar mill and 21 hot sheet mills, with necessary finishing equipment to produce the commercial grades of black and galvanized sheets.

About 1901 The Apollo Iron and Steel Company, the builders of the plant, became part of the American Sheet Steel Company, later to be expanded into the American Sheet and Tin Plate Company. In 1902 this company became a subsidiary of the United States Steel Corporation.

In order to meet the exacting demands of the trade the plant has been improved and enlarged until today it has ten 50-ton and two 60-ton open hearths, blooming mill, bar mills and a full complement of hot rolling, annealing and finishing equipment for producing all grades of black, galvanized, terne, full finished, electric and alloy steel sheets.

Recently the hot mill department has been equipped with continuous heating furnaces, automatic mill tables and conveyors; the annealing department has been entirely rebuilt, including 55 new producer-fired box annealing furnaces of modern design, seven

electric annealing furnaces, facilities for normalizing, open annealing and various other heat treatments;

JULIUS GRAF

improved cold rolling and pickling equipment have been installed; galvanizing, terne coating and auxiliaries required in the manufacture of high grade sheets have been improved and enlarged from time to time.

Well-equipped chemical, metallurgical, corrosion and electrical laboratories are located in the Works, making it possible to carry on the exhaustive tests which are so necessary to the production of uniform quality. Competent metallurgical engineers are constantly engaged in research problems as well as routine testing.

Over 3,000 employees are engaged at Vandergrift Works. The town is essentially an industrial community and many of the workmen are of long experience in the sheet business. These men take a personal pride in the development of the plant and the product.

In conformity with other plants of the United States Steel Corporation, the plant maintains an efficient Safety and Welfare Department, including a visiting nurse who contacts the families of employees.

It may be of interest to note that many United States Steel Corporation and subsidiary company executives, both past and present, have advanced through the ranks at Vandergrift. Among these may be noted Mr. W. A. Irvin, Mr. S. A. Davis, Mr. E. W. Pargny and Mr. D. A. Barrett.

The Allegheny Steel Company

By W. F. DETWILER
Vice President and General Manager, Allegheny Steel Company, Brackenridge, Pa.

The Allegheny Steel Company, in co-operating with the Association of Iron and Steel Electrical Engineers at their annual convention being held October 17-18-19, 1933, at Pittsburgh, Pa., extends a cordial invitation to the society's members and guests to visit their plant October 18, 1933.

A brief history, physical equipment and products manufactured by our company is described in the following paragraphs.

The history, record and development of the Allegheny Steel Company is unique in the annals of the steel industry. Originally organized in 1900 to manufacture and produce sheet steel, this company has steadily extended its operations so that today Allegheny is the world's largest manufacturer of electrical sheets,—and one of the important producers of automobile body, metal furniture and black sheets.

The characteristic thoroughness of the Allegheny organization in developing and producing sheets of unusual qualities has naturally created a demand for other steel specialties,—a demand which has built up a smoothly-co-operating organization of metallurgists, foundrymen and rolling mill experts, and plant facilities second to none in the steel industry. Allegheny Steel produces their own ingots from modern open hearth and electric furnaces,—they operate a large steel foundry for producing acid steel castings from 25 pounds to 50,000 pounds in weight,—they maintain large, modern machine shops,—and the latest type rolling mill equipment.

Metallurgical Research in materials, processes and equipment has always been one of its leading activities. Well equipped laboratories and experienced metallurgists carefully control not only the quality of the raw materials used, but also supervise the equipment and processes of production such as melting, heating, rolling and heat treating.

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Elaborate tests are conducted daily in these modern metallurgical laboratories. Resistance to shock, endurance and effect of temperature on metals are minutely studied—the flow of metals under load at high temperatures and their expansion to heat are

investigated, and the electrical and magnetic performance of Allegheny Steels are tested—all for the purpose of establishing and maintaining the quality for which Allegheny Steels are so favorably known.

This scientific attitude on the part of the Allegheny organization and its desire to delve deeply into the uncharted realms of metallurgy was largely responsible for the early activity of Allegheny Steel in the development of Stainless Steels and their acknowledged leadership today as the largest and foremost producer of Stainless Alloys in the country.

A complete range of corrosion and heat-resisting alloys of austenitic and ferritic composition have been developed—each with distinct metallurgical characteristics and definite application. All of these alloys are rust and corrosion-resisting,—some of them are noted for their high heat resistance—others for their ease of fabrication, permanent beauty of service, etc.

For over twenty years Allegheny Steel has also been an important producer of lapweld steel pipe, boiler tubes and seamless tubular products for the oil and gas industry. Lapwelded pipe is produced in all standard sizes from 2" to 6" O.D., seamless tubular products are produced in both mechanical and seamless grades up to 3" O.D., and in the corrosion and heat-resisting alloys up to 6¾" O.D.

The constantly increasing demand for Allegheny products throughout industry has enabled Allegheny Steel to extend and improve plant facilities and equipment. Even during the depression period, constant improvement and expansion in modern equipment were steadily continued. In 1930 their seamless tube mills were greatly enlarged and equipped to produce stainless and heat-resisting tubing. A little over a year ago a modern 4-High Continuous Mill was installed. This mill is 823 feet long, has a capacity of 800 tons per 8 hours, and handles products of 30-inch maximum width by ½-inch to 12 gauge. From the entrance of the red hot ingot in the blooming mill, through the flattening rolls, edging rolls, shears, quenching tanks and piling,—the time required is just two minutes. The entire mill is electrically operated by a large, modern power plant especially designed and built for the purpose.

The widely diversified line of sheets and alloys manufactured by this company finds application and use in almost every industry and in literally thousands of different products produced by metal fabricators in all parts of the country.

Engineering Developments In The Steel Industry

By J. S. TRITLE,
Vice President and General Manager,
Westinghouse Electric and Manufacturing Co.
East Pittsburgh, Pa.

The steel industry has long been looked upon as a barometer for general business conditions, but during the last two years their business has suffered greater curtailment than many other industries. Great credit is due the steel industry for the manner in which they have taken care of their men under these extreme circumstances and the quiet preparations they have been making to assist in the recovery of business.

When business conditions were good the steel industry installed some of the greatest projects made by any industry. During the last two years it has been very interesting to note the character of the projects that have been installed, in spite of extremely adverse business conditions. It is true that the installations have been small and few in number; however, in each instance they have represented a conservative and a very logical step in the production of a superior product, or the accomplishment of a more economical method of manufacture.

The introduction of modern furnaces and automatic mechanical equipment for handling sheet represents a great stride in the hot mill division of the

J. S. TRITLE

sheet mills. The old style of rolling involves a large amount of drudgery with only small tonnage production. Automatic electrical control makes its possible to transfer the metal from the furnaces to the mills and through the mills without the strenuous labor previously required.

The rising demand for strip steel in thinner gauges and rolled to closer tolerances has led to the rapid development of cold roll mills during the last year. The co-operative efforts of rolling mill man, mill builder and electrical manufacturer have resulted in the development of special equipment for producing a superior quality of tin plate and thin material for the exacting requirements.

A new steel mill in the Detroit district has started

making steel by a new process. Scrap steel obtained locally is melted in an electric arc furnace, cast into billets in centrifugal casting machines, and rolled into bars and shapes. The process enables the production of steel with a comparatively small initial investment per ton.

A mill in the Cleveland district found it profitable to dispose of their blast furnace plant and obtain steel from another plant of the same corporation. The blast furnace gases were no longer available for electrical power plant heating so the electrical frequency of all of their electrical equipment was changed and power was purchased from a local generating station.

Promotion and installations of projects of this kind justify themselves even when business conditions are abnormal. They take the drudgery from the laborer's daily life. They answer the customer's increasing demand for better products. Lastly, and of primary importance, they avoid an artificial expenditure of money which may or may not be a real contribution to our recovery program.

Electric Power And The Steel Industry

By J. D. WRIGHT,
Chief Engineer, Industrial Engineering Dept.,
General Electric Co., Schenectady, N. Y.

Even a most casual review of the part which electricity has played in the progress made by the steel industry will reveal the fact that the contributions made by it have indeed been of major importance. Starting out in a small way with railway type motors used to replace small steam engines on auxiliary drives, applications have increased until

J. D. WRIGHT

now little, if any, consideration is given to any other method of driving steel mill machinery.

It is interesting to review briefly the advances which have been made in the application of motors for main roll drives. The first installation made in 1905 consisted of two 220-volt direct current motors. However, it was the rugged, constant speed, direct connected induction motor which was first applied in large numbers and which demonstrated the economies to be secured by electric drive. There soon arose a need for adjustable speed drives on some types of mills. This brought about the utilization of 2 and 3 speed induction motors (changeable pole type) and the Kraemer and Scherbius systems of A.C. adjustable speed control. Some few relatively small direct current motors were also used.

Developments in heavy duty herring-bone gears, soon made it economical to use higher speed geared motors instead of slow speed low power factor direct connected induction motors.

It also was not long before direct current motors showed their superiority as drives for reversing blooming mills and beginning about 1913 and 1914 most new reversing mill installations and many existing steam engine driven reversing mills were equipped with direct current reversing type direct connected motors.

The application of the old reliable constant speed induction motor reached a peak in the years 1919 and 1920. Since then in spite of a rapid increase in the number of main roll drive installations, the ratio of induction motors to other drives has shown a fairly rapid decrease. This has been brought about largely by two important developments. The first, and most important, occurring within the steel industry itself, was the development of the continuous hot strip mill. The second factor was an improvement in the characteristics of synchronous motors which made their application to constant speed mills more feasible. This change was aided of course by the rapid increase in the capacity of the steel plant and public utility power generating stations.

It is difficult to believe that the development of the highly powered continuous hot strip mill would have been possible without the flexibility and refinement of control made available by electric motor drive. Rolling conditions made necessary a wide range of speed adjustment and this, together with the accuracy of speed control essential because of close spacing of the individually driven roll stands, made the direct current motor eminently suitable as a drive for such mills. As a result, the increase in the number of direct current motor installations was very rapid. For example, in 1919 80% of all main roll drive motors sold by the General Electric Company were constant speed induction motors. In 1926 only 22% of the total number sold were induction motors and the number of adjustable speed non-reversing direct current motors had risen from approximately 12% to 60%.

One of the latest rolling mill developments, which it is still more difficult to conceive as being possible

with any form of driving power other than electric, is the single stand reversing cold strip mill with constant tension reels. The operating conditions here require a precision and refinement of control wholly undreamed of in any previous type of mill. For example, an adjustable speed motor is required for the mill itself. Two adjustable speed motors are required for the two reels. These three motors must operate together to maintain constant tension on the strip during acceleration, at maximum speed and during retardation. In an extreme case the acceleration force for the unwinding reel may be equal to or even exceed the required strip tension. The speed of the reel motor must decrease as the strip builds up on the reel and of course increase as it unwinds. The tension on the winding side may be several times the tension on the unwinding side. The speed of the winding reel must at the same time be greater than that of the unwinding reel as due to the draft the delivery speed is higher than the entering speed. The actual delivery speed of the mill may be made to vary through an exceedingly wide range, depending on the product being rolled. The desired tension also depends upon the product and may be required to vary through a 150 to 1 range.

Today electricity is entering the service of our steel mills, on what promises to be a very large scale, in the comparatively new role of a source of heat for processing steel. Electrically heated furnaces provide a precision means of controlling temperature, rates of heating and cooling, and composition of furnace atmosphere which can be obtained in no other way. Quality and uniformity of product, elimination of costly handling, reduction of time in process, betterment of working conditions all contribute to make the electric furnace superior for many mill heating operations. Among the applications which have already been made may be mentoned the following.

Cylindrical bell type furnaces are being used very successfully for annealing coiled steel strip in a controlled atmosphere. The product is of uniform hardness throughout, has a bright finish, and the annealing time has been cut approximately in half.

Electric furnaces of both the bell-type and the continuous type for annealing high-silicon steel give promise of making available a steel having a very low watt-loss, for use in the electrical industry. Here again uniformity of temperature and atmosphere control are the prime factors.

For heat treating high grade alloy steel bars the electric furnace has proven its ability to improve quality and reduce costs. A completely automatically controlled heating and quenching cycle permits the duplication of results with amazing uniformity.

The use of electricity as a motive power has made possible many improvements and refinements in rolling mills, in certain cases even resulting in revolutionizing some phases of steel production. Now the use of electricity as a source of heat holds forth the possibility of even greater refinements, even more revolutionary changes in the industry in which all of us in the A. I. & S. E. E. are so vitally concerned, the manufacture and processing of steel and other metals.

LIST OF EXHIBITORS
IRON AND STEEL EXPOSITION

OCT. 17—19, 1933 PITTSBURGH, PA.

ALLIANCE MACHINE CO.	16	JOURNAL LUBRICATOR CO.	C-105
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FOXBORO COMPANY	17	S-K-F INDUSTRIES, INC.	9-10
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GENERAL ELECTRIC SUPPLY CORP.	51-52	TOOL STEEL GEAR & PINION CO.	27
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GRAYBAR ELECTRIC CO., INC.	14	UNITED AMERICAN BOSCH CORP.	32
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Developments In The Iron and Steel Industry 1932 - - 1933

By W. H. BURR,
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To be presented before A. I. & S. E. E. Annual Convention in Pittsburgh, Oct. 17-19, 1933.

In the years which are to come, this nation will refer to 1932 as one of the leanest of the lean years in the production of steel. The pendulum in its downward swing has passed its lowest point and has started on the upward swing with a momentum such as we were beginning to think would never again be possible. Naturally, during such a period of depression, developments are not given their usual consideration. Business is improving and things are happening with unusual rapidity. Never before have we witnessed such developments as have taken place in the last six months in our Federal Government. Even under these conditions, a great amount of development work has been carried on, much of which may not be utilized until the demand for increased production makes this advisable.

W. H. BURR

Charts

In order that the records of this association may be complete, we have brought up to date the charts showing the total number of mill drives of 300 HP, and over, installed during 1932 and the total installed to date, also charts showing yearly and total HP installed on all types of mills. Those covering the yearly and total HP installed on various types of mills have also been revised. New installations during the year were confined to the Strip Mills, Skelp Mills and Merchant Mills.

New Process for Making Steel

Of particular interest this year is the new rotary process of making steel. One hundred per cent steel scrap is charged into an electric furnace; the melt is poured into a mold revolving at high speed; the resultant 2-ton circular bloom, 7 x 7 inches in section and 10 feet in diameter, is sheared into arcuated sections; a flash heat brings these sections up to rolling temperature and they are ready for billet conversion on a breakdown mill. A plant for making steel by the rotary process is nearing completion in Detroit.

Combustion

No doubt the two most interesting developments in combustion field are: Luminous Flame Combustion and One-way fired Open Hearth Furnaces.

On existing furnaces there has been intensive effort to cut fuel cost and shorten time of heats. This has led to new methods of burning fuel in the Open Hearth furnaces.

A large eastern company has been trying a top fired furnace and a midwest concern is advocating firing from all four corners.

Real progress has been made in the control of Open Hearth furnaces. Constant analyses of existing gases are now possible and furnace combustion regulated automatically from these analyses.

Turbines

For the first time a turbine-generator set was designed for outdoor operation. It is a noncondensing unit and produces 6,000 kw. by reducing the pressure of the 400 lb. steam in a mercury-condenser boiler to 250 lb. for use in the shops.

The principal outdoor feature is a special lagging that covers the turbine casing and bearing brackets as well as the collector rings and exciter. The bearings are equipped with sight-flow indicators located under windows in this lagging. The valve gear parts are all of noncorrodible material to withstand the effects of the weather.

Condensers

A 65,000-square foot condenser, constructed by electric welding, is the latest mile post in the progress of the art of joining metals; an art which year by year has been employed with greater confidence, and on larger structures.

The welding of this huge condenser presented no serious problems. However, designing it for welding involved a rearrangement of the shell strengthening members, in view of which exhaustive tests were made upon a one-sixth-scale model, which showed a strength greater than calculated. It is not long since condensers with their vast size, and sometimes peculiar shape, seemed an unpromising field for the enterprise of welding engineers, but welded condensers are tighter, lighter, less liable to porosity, and, engineers believe, will soon become the normal type.

Steam Turbine-Generators

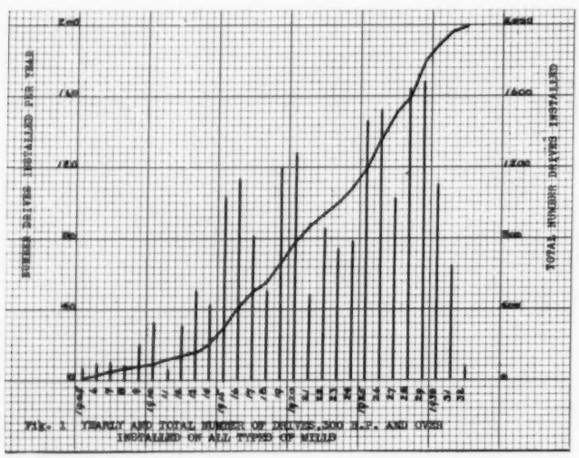
A second 160,000 kw., 1800 rpm, tandem-compound turbine-generator was placed in service in the Hudson Avenue Station of the Brooklyn Edison Company. A complete set of instruments for observing and recording the operation of this turbo-generator was developed and installed to supplement the personal element in judging the operation of the unit with instruments that give both a remote indication and a permanent record of turbine performance.

Among the instruments are an electric eccentricity recorder, an expansion recorder, an interference recorder for rotating parts that will indicate and record a squeak or other sound, a vibration ampli-

fying recorder with detectors on each bearing, and Selsyn power amplifiers for the remote operation and indication of valves.

Transformers

Of interest to steel companies operating electric arc furnaces is the development of a motor-operated, tap changing switch mounted inside the transformer casing. The switch provides for connecting the high voltage windings of the transformer, either delta or Y, and may also provide for two taps on each connection. This switch of course greatly decreases the number of oil circuit breakers required to control a multi-voltage arc furnace. Heretofore, it has



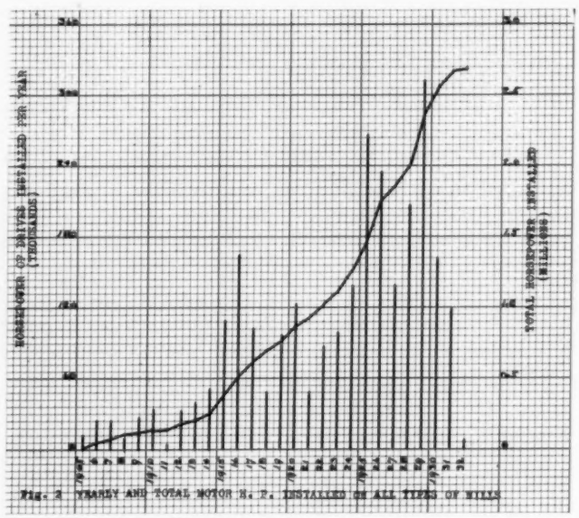
been necessary to place furnace and other high-capacity transformers with low-voltage high-current secondaries indoors. Now, however, a low-voltage weatherproof bushing for secondary bus bar terminals is available which permits mounting furnace and similar transformers out-of-doors.

Transformers filled with a non-inflammable insulating liquid, called Pyranol, are now available in sizes up to 500 kva. Pyranol is a new non-inflammable insulating and cooling medium, which is heavier than water, non-sludging, non-oxidizing, and non-acid forming. Pyranol-filled transformers eliminate the fire hazard of inflammable liquids.

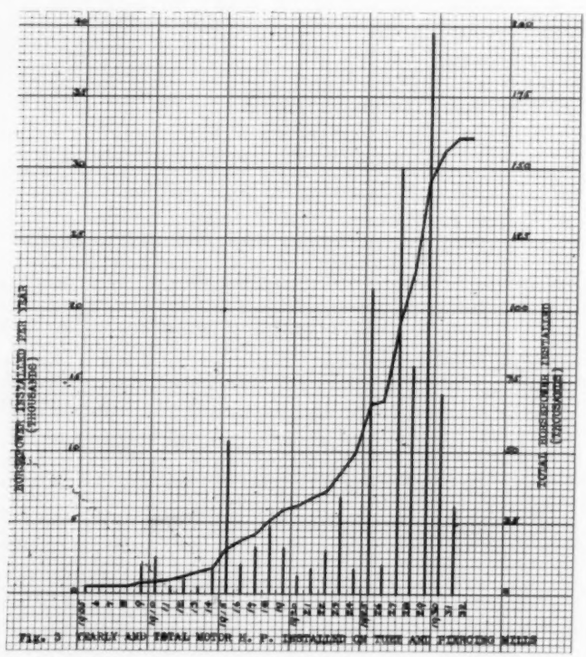
On distribution transformers there has been introduced a detachable stud as well as cable bushing which has its advantage in that it can be attached from the exterior of the case without the necessity of removing the cover. This feature eliminates the necessity of handling tools inside of the transformer case whenever a bushing has to be tightened up or replaced.

A number of power transformers of exceptional ratings and physical dimensions were built, some of which were so large that it was necessary to provide specially constructed freight cars for their shipment. Many of the details of power transformer construction underwent a modification in design to utilize in a practical way the results of lightning investigations and to secure a higher factor of safety by the coordination of the insulating values of transformers and the protective elements of power systems.

For the protection of distribution-type transformers, it was found feasible to locate intershunt Thyrite arresters inside the transformer tank, thereby simplifying installation practice and providing a distinct advance in the over-all protection of distribution lines.



An improvement has been made in the coil construction of large transformers used in connection with steel melting and other furnaces, also for various chemical processes. The improvement consists



of arranging the primary winding in such a manner with respect to the secondary that practically a uniform reactance exists between the two windings throughout the full range of secondary voltages. This gives a low reactance which is highly desirable on transformers which carry heavy amperes. This

construction gives another advantage. A coil so constructed has an additional advantage in the fact that the primary and secondary are practically balanced with respect to one another against mechanical stresses caused by heavy overloads or short circuits.

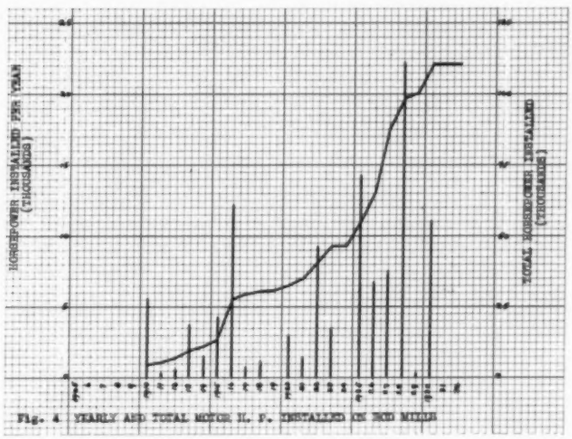


Fig. 4 YEARLY AND TOTAL MOTOR H. P. INSTALLED ON HOT MILLS

The new surge-proof transformer combines better-built transformers, more effective arresters, and a better understanding of lightning. The protective elements are built inside the walls of the transformer itself; and though the intention is that a ground wire shall be used, the protection is effective even without it. When an incoming surge raises the potential of the high-voltage winding, a pair of spark-gaps flash over to the case, and a third gap flashes over, connecting the case to the ground and discharging the over-voltage and the gaps are self-extinguishing. They invariably interrupt the current in half a cycle or less—so rapidly, in fact, that the primary fuse will not blow, nor an overload relay operate. Even in case the ground connection

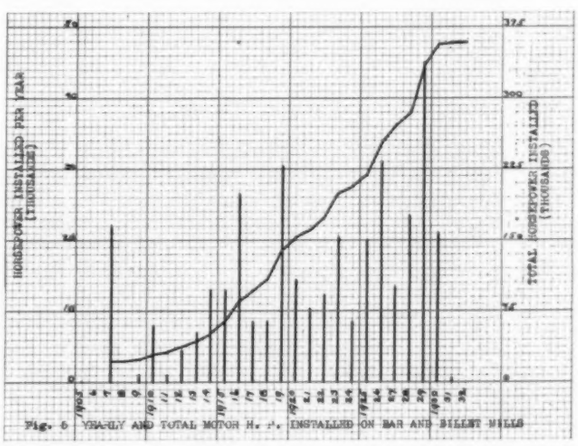


Fig. 5 YEARLY AND TOTAL MOTOR H. P. INSTALLED ON BAR AND BILLET MILLS

is missing, the surge is dissipated through the grounds on the secondary.

Electric Furnaces

The trend of modern electric furnace development is toward the use of a protective atmosphere in the heating and cooling chambers, to prevent oxidation of material being heated, or in some cases to reduce the oxide already on the material.

Development and installation of two types of atmosphere producing equipment were made. One of these is an ammonia dissociator in which tanked anhydrous ammonia is connected to the coiled alloy tube, which contains a suitable catalyst. The coil is placed in an electrically heated chamber where the temperature is automatically controlled at the proper value. The ammonia gas is dissociated giving a mixed gas containing 75% hydrogen and 25% nitrogen. This gas is produced at a cost of approximately $4 per M. cu. ft., which includes the cost of ammonia and of electric energy. This figure is based on the price of ammonia in cylinders. If purchased in tank car lots, this cost may be reduced 50% or more. Such a gas is suitable as a

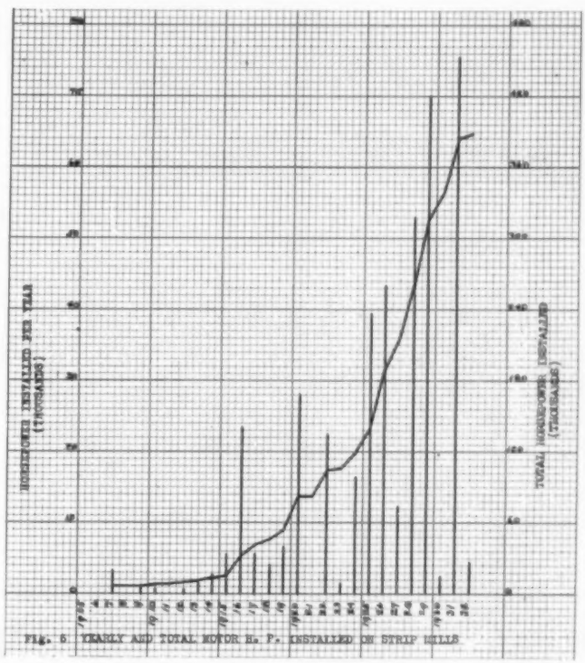


Fig. 6 YEARLY AND TOTAL MOTOR H. P. INSTALLED ON STRIP MILLS

protective atmosphere for practically all applications where hydrogen is suitable, and is much less costly than tanked hydrogen gas.

Another atmosphere producing equipment was developed to provide an atmosphere of low cost. It consists of a device for controlled mixing of air and gas, (either gas or natural gas), a combustion chamber in which the gas is reformed, and a cooling coil where excess moisture is removed. The analysis of the gas can be varied from one that is practically neutral to one that is highly reducing in character, by adjusting the ratio of air to gas. The cost of the atmosphere produced in this equipment is approximately 10c to 30c per M. cu. ft. (when using city gas of approximately 500 BTU content), depending upon the air-gas ratio and the cost of the raw gas used. For natural gas, the cost is even lower.

Main Roll Drives

One of the applications which was made in steel mill drives during the last year covers the 1,000 hp, 600 volt, 400-800 rpm, direct current motor driving a 38" Steckel mill installed at the Follansbee Bros.

Co. plant. This motor is supported from a 750 kw, 80% power factor, synchronous motor generator set with direct connected exciter. The control for the synchronous motor of the set is of the automatic reduced voltage type. The Ward-Leonard principle is used in the starting and speed setting of the direct current mill drive with choice of speed under hand control, with automatic acceleration and acceleration under current limit relays.

The new continuous wide hot strip mill of the Otis Steel Company, which is one of the largest mills of this type in the country, was put into operation. Their 72-in. cold strip mill was also placed in service. This is the largest cold strip mill which has so far been installed, each of the two stands being driven by a 1500-hp, 200-400 rpm, direct-current motor, while the reel is driven by a 400 hp, 300-1050 rpm motor. The reel motor and control automatically maintain any desired value of tension in the strip between the reel and the last stand.

Progress was made in the development of automatic equipment for increasing the production of sheet-rolling mills by constructing a simple device which permits the roller to get a fairly exact indication of the length of the sheet after each pass. A small Selsyn generator is geared to the mill so that its speed is proportional to the speed of the sheet through the mill. A Selsyn receiver is connected through a magnetic clutch to a pointer on a dial which indicates the length of the sheet. The clutch is controlled by a flag switch actuated by the sheet as it comes through the mill. When the front end of the sheet depresses the flag switch the clutch is energized, connecting the pointer to instrument Selsyn which is rotating at a speed corresponding to the sheet speed. The pointer then begins to rotate and continues until the tail end of the sheet passes over the flag switch, releasing it. Obviously, the position of the pointer at this instant is an indication of the length of the sheet. The device can either be arranged so that the pointer immediately resets, or it can be held in this position for a few seconds, and then automatically reset.

A Selsyn transmitting and receiving unit combination was adopted to transmit directly to the pulpit the indication of the position of the top roll on a blooming mill.

A combination of Selsyn mechanisms and Thyratron control tubes was utilized for the remote control of a 5 hp motor, which in turn operates the hydraulic control valve on a 300-ton bloom shear. The position of the shear valve accurately and automatically follows the position of the small master switch which is controlled by the operator.

Thrustors are being increasingly used in the steel mills. A number of them are employed in tilting tables which take the sheets away from the sheet rolling mills and deliver them to the shears. Some of the largest Thrustors so far built, rated at 4,000 lb.ft., 18-in. stroke, are used to open the doors of large reheating furnaces. A Thrustor is also in use operating the looping mechanism on a 14-in. strip mill. Previously, air, hydraulic, or motor-operated mechanisms were employed.

Auxiliary Motors

To meet the demands of the ever changing conditions of modern industry, a 100 hp motor, less than 12 in. in diameter, has been built which is to supply the maximum amount of power in an almost unbelievable small diameter. Like a dachshund in appearance, this unique motor has the power of motors that are several times in diameter. This induction type motor is ideal for direct-mounted grinding wheels, saws, cutterheads, etc., where the diameter and peripheral speed of the cutting tool must be held to a minimum.

There has been placed on the market a Varidrive motor which consists of a simple squirrel-cage motor and a variable speed differential which comprises dual discs coupled with the Varibelt. The differential discs, which are called Varidiscs, reciprocally expand and contract for higher or lower speeds, transmitting power through the Varibelt to the take-off shaft. Because of its few moving parts, Varidrive is said to be reliable, durable, and will operate continuously, trouble-free. This motor is arranged for local or remote control. A hand wheel is mounted on the unit for local control. For remote control a push button station or a hand wheel may be installed at the most convenient location for the operator. Automatic remote control can also be furnished.

Small motors which can be stalled on the line for months at a time without injury are now being made. The explanation is in a thermostat which opens the circuit when the motor gets too hot, and connects it again after it has cooled. Such a motor, with the rotor locked, was put on the line and left for two months and a half. It survived, undamaged.

Brakes

A new clapper type AC brake was developed especially for sheet mill service. This brake was designed to operate forty times a minute and to give better than 20,000,000 operations without replacing any major parts. There are only two adjustments, one being for torque and the other for lining wear. Both of these are on the top rod and can be made with a ½" wrench. The brake is so arranged that no adjustment for clearance between brake shoes and brake wheel is necessary.

Control

Relatively very little new control apparatus was installed during the year 1932. However, the sheet and tin mill division of the industry enjoyed a production which was considerably greater than that of any other division and a number of new control devices were developed for use in the sheet industry, particularly in connection with automatic roller and catcher tables. It was necessary to develop magnetic contactors having a much longer life than that of the contactors which were available and also to arrange these contactors for rapid operation. The currents which have to be handled are relatively low so that the principal problem was the design of a good mechanical structure. The contactors designed for sheet mill service have long bearings and a sturdy mechanical construction throughout. The magnetic gaps are generally short which reduces the slam in closing and tends to eliminate wear from hammering of the laminations of the frame. Stops have been increased in size and bearings and bear-

ing pins have been hardened. Similar points of construction have been used in designing control relays for sheet catcher service. The contactors and relays will give a service life far greater than that which was obtainable with standard contactors.

A new rotating cam limit switch was developed for sheet mill service. This switch has double break contacts with silver tips. The cams are 6" in diameter so that it is easy to obtain an accurate stop. The cams are easily adjustable, both as to length and position. In making adjustments it is only necessary to loosen a single locking nut at one end of the switch after which any cam can be adjusted without interfering with the adjustment of other cams. When the adjustments are complete the device is locked in position by tightening the nut. The wearing parts of the switch are made of hardened steel and the shaft turns in ball bearings. The bearing flange on the driving end of the switch is fastened to the inside of the end plate and the bearing flange on the other end is larger in diameter and fastened on the outside of the bearing plate. With this arrangement the entire cylinder can be removed by taking off the two end flanges.

A new type of flag switch was developed especially for sheet catcher work. Previous designs have attempted to make the moving parts of the flag switch as light as possible in order to prevent overtravel. In the new design the parts are made as heavy as is consistent with strong construction for hard service and the overtravel is eliminated by the use of friction bearings. The switch is constructed of welded boiler plate and is arranged with two compartments; one of these compartments houses the contact mechanism and the other houses the centering spring mechanism. A flag lever is made of high carbon tool steel and the roller, at the end of the lever, is of hardened steel. The switch is provided with two sets of silver contacts, one normally open and the other normally closed.

There has been a growing demand from the steel industry for the development of a screwdown controller by means of which the stopping points of the screwdown motor can be pre-set so as to automatically give the proper opening of the main rolls for each successive pass. This demand has resulted primarily from the need for improved quality of product as a result of taking proper draughts.

The screwdown controller as developed permits the setting up of one or several predetermined rolling schedules to take care of various sizes of ingots that may be in the soaking pit and to take care of various sizes of finished blooms to which these ingots are to be rolled. The operator can change instantly from one predetermined schedule to another by pushing a button. It is possible to change one complete schedule set-up to an entirely different one in about a minute and a half if a rolling schedule entirely different to the ones for which the controller has previously been set up should come along.

To move the rolls from one pass position to the next, the operator pushes a button; the screwdown motor quickly accelerates, slows down in two steps of armature shunt, and is stopped by dynamic braking assisted by a magnetic brake.

The operator, at all times, has the ability to operate the screwdown with a standard master controller. In case of emergency, moving the master control handle immediately takes control away from the automatic set-up. He can finish the piece by manual control or after one or two or more passes, he can return to the automatic schedule.

This automatic screw-down controller is suitable for many types of mills including blooming mills and other roughing mills and various types of finishing mills with motor driven screwdowns. On finishing mills the ability to obtain extreme accuracy of gauge on the final pass is an important feature of this control.

Of particular interest to users of resistance welders is the automatic weld timer which automatically controls the heat units put into the weld. Unlike many prior developments in controlling welding time, it does not operate on the principle of a fixed welding time but varies the time to compensate for the many variables that enter into making a perfect weld, such as variations in voltage, variations in resistance of the pieces being welded due to surface conditions, thickness of metal, condition of electrode points, etc. This weld timer permits an inexperienced operator to turn out sound welds at all times.

Practically coincident with the design of special contactors for sheet mill service has been the design of a line of contactors for welding service. Again the requirements call for sturdy construction and long mechanical life, but in addition these contactors are required to handle heavy current and also to operate very rapidly. Contactors have been developed which will operate at the rate of 800 times per minute intermittently and continuously at the rate of 200 times per minute.

There has been designed and built a complete control equipment for starting, reversing and dynamic braking in stopping a 1,000 hp, 2,200 volt synchronous motor. This control equipment was a departure from the usual makeup insomuch as oil immersed magnetic contactors were used instead of circuit breakers in some parts of the equipment. A circuit breaker was used to provide the necessary interrupting capacity on the occasion of heavy overloads or short circuits. One of the main requirements on this particular synchronous motor installation was that of a quick stop after a safety emergency cord had been pulled. Prior to this installation, the best that the plant had been able to get averaged from 18 to 20 inches travel of the surface of the roll after the emergency cord was pulled. With this installation they succeeded in getting down to 11½ inches of surface travel of the roll every time the emergency cord was pulled. In other words, the time required to stop was reduced nearly 50%.

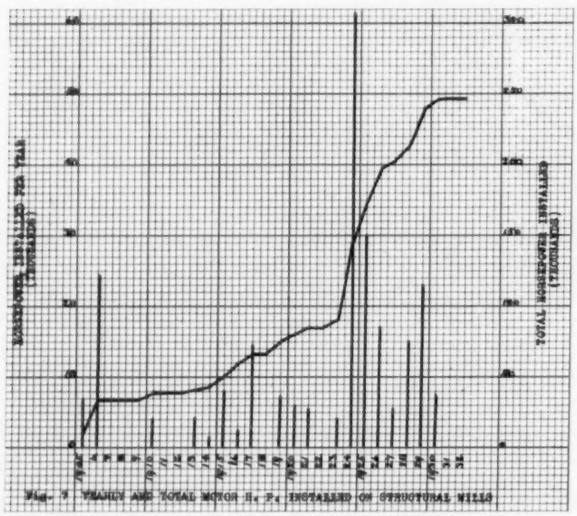
Circuit Breakers

As a result of recent developments there is now available an oil circuit breaker which has demonstrated by test that it will withstand more than 10,000 operations making and breaking 1,000 amps. at 6,600 volts, or 1,200 amps. at 2,300 volts without change of oil or renewal of tips. This breaker is designed particularly for AC main roll motor starting duty where it may be subjected to very frequent operation, amounting in many cases to notching service.

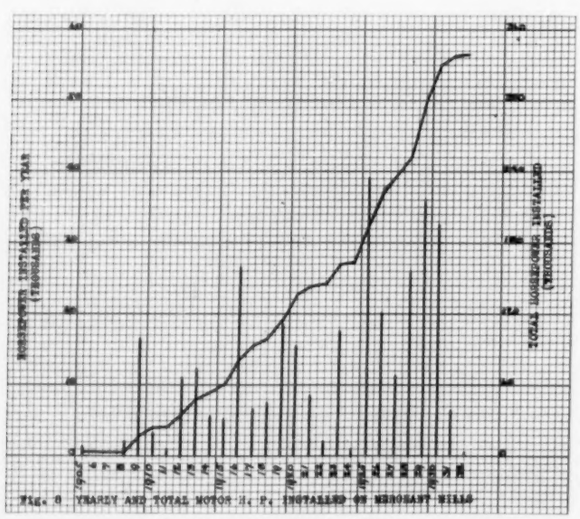
The breaker is designed for 15,000 volts and is

built in normal ratings of 600 and 1,200 amps. The interrupting capacity is 100,000 kva, and the short time current capacity 60,000 amps. for one second.

The contacts on this breaker are the result of extensive investigation, testing and field experience. The primary, or main current carrying contacts, are



of the conventional 45 deg. wedge type. The secondary or arcing contacts are of novel construction. They are of the butt type, rectangular in shape, of large area and volume. The large volume supplies the necessary body to prevent the surface of the contacts from becoming excessively heated. it also supplies the necessary amount of material to secure the large number of operations. The large area used, allows the arc sufficient burning area to prevent concentration of the burning on a small spot. It also eliminates any tendency towards contact welding on closing.

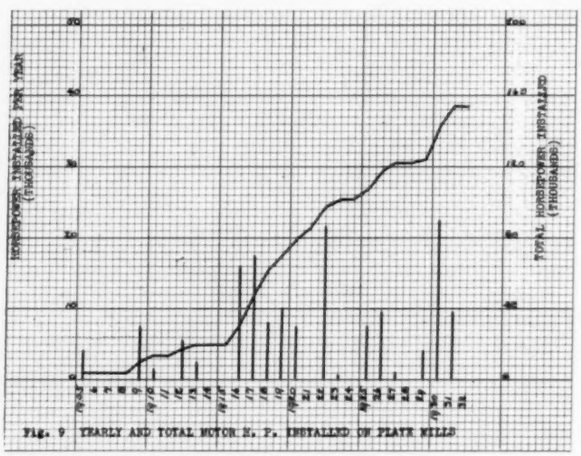


Compression springs are used in the stationary button contact to give the necessary pressure to insure good contact and to minimize arcing on closing. The arrangement of the shunts insures proper distribution of magnetic stress and high contact pressure during operation under heavy current. A special means of guiding the stationary contacts restrains their motion to insure the handling of extremely high current, and at the same time allows sufficient freedom of motion to insure good contact alignment and prevent sticking or binding of the contacts.

A new type of air circuit breaker has been developed for the control and protection of industrial circuits and other applications. This is the compression type unit. It is available in ratings from 15 to 600 amps., 600 volts AC and 250 volts DC, single, double, and triple pole. The 15 to 50 amp. breakers have an interrupting rating of 5,000 amps., and the larger sizes will interrupt 10,000 amps.

These breakers offer speedy restoration of service, tamper proof protection, and quiet operation. Interruption takes place within a closed chamber, and the arc generates a pressure which increases the resistance of the arc path so rapidly that the circuit is interrupted in approximately 0.008 seconds.

Thermal trip is provided in the 50 ampere frame size while the larger sizes have thermal trip for



overload protection and magnetic trip for short circuit protection.

These breakers are quick make, quick break, and trip free. The target indicates when the breaker has tripped due to overload. Breaker parts are enclosed in a housing of textolite.

Magnets

An auxiliary controller for a lifting magnet has been developed. This controller is used in connection with the main magnet controller and is for the purpose of increasing the lifting capacity of the magnet. The controller consists of a spring closed contactor which is opened by a timing device after the circuit has been closed to the magnet. The opening of the spring closed contactor inserts a resistor in series with the magnet winding.

It has been found that when a lifting magnet rests on a pile of loose material the material itself becomes magnetized. In lifting away the magnet will raise a certain amount of material. Other material will be magnetized in such a manner as to oppose the lifting of material. There will, therefore, be a certain amount of material which, while it is attracted to the magnet, will at the same time be attracted in the opposite direction by material on the pile. This is equivalent to saying that in hand-

ling loose material the magnet will hold more than it will lift. Or, to put it another way, will hold the same amount with a smaller amount of current. It is, therefore, safe to reduce the current in the magnet after it has lifted away from the pile. It has been found by experiment that the current can be reduced to 70% which reduces the heating about 50%. This reduction in heating prevents the resistance of the magnet from increasing to the value which it ordinarily would and consequently permits more current to flow through the magnet after it has reached its operating temperature. It is well known that after a magnet has reached its running temperature it will not handle as much loose material as it will when cold. The purpose of the auxiliary control is to prevent the magnet from heating so much and keep its lifting power nearer to that of a cold magnet. Tests have shown that with this auxiliary equipment the lifting capacity of a magnet is increased about 10%. The auxiliary control is only effective where the magnet is handling loose material such as pig iron, scrap and steel turnings.

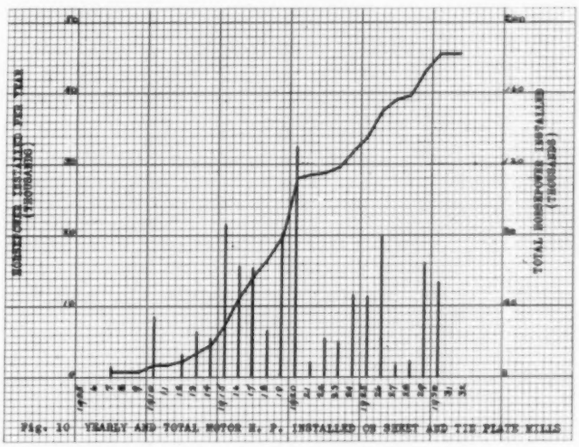


Fig. 10 YEARLY AND TOTAL MOTOR H. P. INSTALLED ON SHEET AND TIE PLATE MILLS

Tubes

For the first time, a rectifier utilizing Phanatron tubes was placed in commercial service to take alternating current from a 13,800 volt distribution line and supply 250 volt direct current to an Edison three wire system.

This hot-cathode mercury-vapor rectifier tube consists of an indirectly heated cathode surrounded by a metallic shell which acts as the anode and as the enclosing envelope. Each tube is capable of rectifying 100 amp. average current at the usual commercial voltages and frequencies.

Lighning Protection

While the emphasis in developmental work was directed to an unusual extent along lines which would produce improved apparatus of immediate commercial value, research work, both in the laboratory and in the field, was by no means neglected. The investigations of lightning phenomena were continued in the field and the equipment for corresponding work in the laboratory was added to by the construction of a 10,000,000 volt artificial lightning generator of record capacity.

New Wire Insulation

Recently there was announced the invention and development of a distinctly new type of wire insulation.

This special form of insulation was developed primarily for low voltage secondary network distribution.

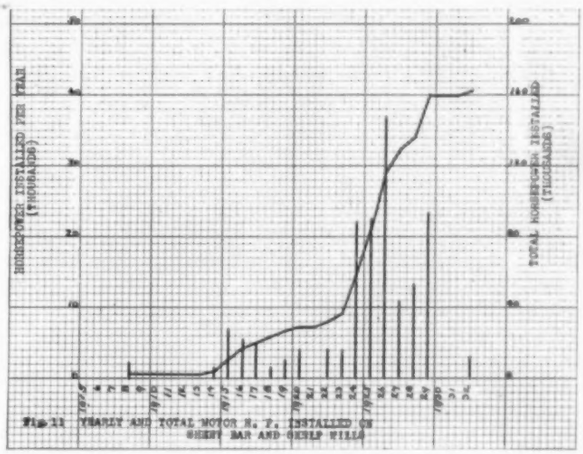


Fig. 11 YEARLY AND TOTAL MOTOR H. P. INSTALLED ON SHEET BAR AND SKELP MILLS

In the modern secondary network system everything is tied in solid without protective devices. When faults occur in the feeders, sufficient capacity is available to burn off the cable and thus open the circuit and the properly laid out secondary network is designed to do this. The chief difficulty is that with all ordinary organic insulation, toxic and explosive gases are given off under fault conditions and these are the cause of manhole explosions and delay in getting down into manholes to pull out the

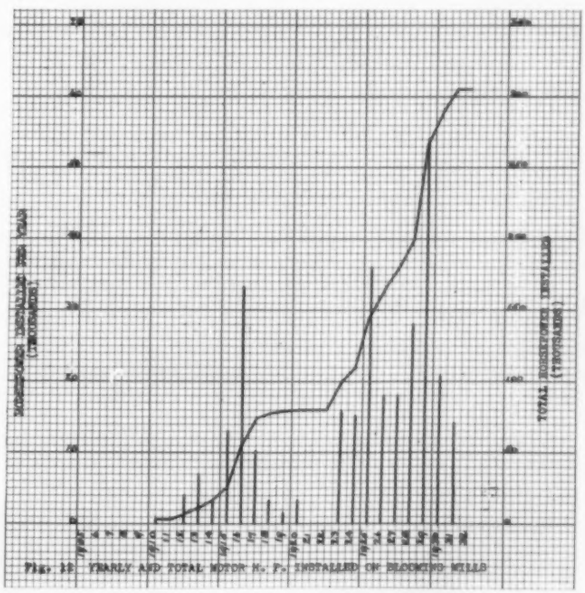


Fig. 12 YEARLY AND TOTAL MOTOR H. P. INSTALLED ON BLOOMING MILLS

faulted feeders and repair the damage. Naturally there is also a considerable fire damage because of the failure of cables to clear without burning back.

In tests made in underground ducts with both tight and loose single, two and three phase faults, the cable cleared with but little evidence above

ground. There were no explosions, no lifting of manhole covers and only slight wisps of steam around the corners.

The remarkable performance of the new insulation is due to the fact that it contains no organic material whatever, consequently there is nothing to carbonize, nor give off smoke.

Another novel characteristic is the action of the insulation under moist conditions. Leakage currents, caused by the insulation taking up moisture, dry out the insulation faster than the moisture can penetrate it and the insulation returns to its original characteristics of dielectric strength and insulation resistance.

Meters

Among the new instruments produced were electric gauges for multiple simultaneous measurements, an isthmus electro-magnet for measuring the magnetic saturation value of magnetic materials, a magnetic analyzer for determining the percentage of iron in non-magnetic materials, a full-range permeameter for determining the normal induction curves and hysteresis loops of magnetic materials, a surge crest ammeter for the direct measurement of crest values of surge currents and a vibration velocity meter for use in the noise-producing frequency range.

For observing temperatures in short intervals there has been developed photoelectric type indicating pyrometers which will respond fully to changed temperature conditions in a period of 0.1 second. The use of this instrument permits observing quantitatively the non-uniformity in temperature along a rod or sheet, particularly at the ends.

A new, compact, portable instrument kit has been designed for testing motors or any alternating current electrical circuit. It is provided with instruments so that readings of amperes, volts, watts or power factor may be taken. Switches on the unit enable readings to be taken over a wide range of capacities.

Alternating current tachometer generators have been developed for measurement of speed. The principle features of these units are the elimination of the commutator, brushes and slip rings which are present on the previous DC types. They are also arranged for mounting directly on the end of a shaft so that gears, belts, pulleys, etc., are eliminated.

A new trend has been displayed in the design of certain recording instruments and precedent has been completely cast aside to create an instrument specifically adapted to fulfill certain needs. The features of this series may be summarized as follows: A degree of interchangeability of parts which has never before been obtained. Heavier and more powerful spring clocks, mounted complete with all chart driving mechanism on a single base plate. More powerful synchronous clocks, mounted on a single base plate and readily interchangeable with the spring clocks described above. Removable separate units in the clock, such as escapement, spring barrels, synchronous motor, etc. Winding of spring clocks from the front which feature is essential in flush type instruments. Ease of coupling chart drives of adjacent instruments, and simplicity of attachment of external motor drive.

During the year 1932, there was placed on the market a new line of long distance metering equipment. With this equipment, it is possible to record over any ordinary telephone line at a distance up to 50 miles, the indication of any standard type of primary measuring element, using a simple milliammeter at the receiving point. Such an instrument makes possible the measurement of water level in a distant tank or reservoir, makes possible the measurement of pressure at a distant critical point on a pipe line, makes possible the totalizing of electrical power of different frequencies or types of circuits all on one instrument, makes possible the measurement of output of a power plant at a point remote from the plant itself.

The mechanism of this transmitter instrument is one which utilizes vacuum tubes for its operation, and yet in which the quantitative behavior of the instrument is independent of the characteristics of the tubes. This is one of the few industrial applications of the vacuum tube in quantitative work where the final measurement does not vary with changes in line voltage, with changes in circuit resistance, or with variations in plate resistance or amplification factor of different tubes or of a given tube. The operation of this instrument is automatically self-correcting for any or all of the above mentioned variations.

Conclusion

Many things have happened since the last annual report was prepared and much has been said and written concerning our modern developments. The fact still remains that developments have improved man's living conditions in recent years so that during the worst period of this depression he was far better off than during the most prosperous years several generations ago. The trouble then is not with our modern engineering developments, but with our methods of distribution and human relations. These problems are now being given very serious consideration and there never was a time when as much effort was put forth to relieve suffering of our fellow men and improve human relations as has been put forth during the last two years. With the same powerful influences working on these problems as have been working on new developments, real progress will be the final result.

With the curtailment of expenditures and reduction in engineering staff in most organizations, it would be only logical to expect a lack of interest in the work of this committee during the past year, but such has not been the case. I wish to express to the members of this committee my sincere appreciation for their continued co-operation, and to the organizations who have assisted in gathering this information, this association is truly grateful.

The Part Welding Will Play In Metal Houses

By BENNETT CHAPPLE
Vice President, The American Rolling Mill Co.
Middletown, Ohio

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Abstract of paper to be presented at A. I. & S. E. E. Annual Convention in Pittsburgh, October 17 to 19, 1933.

You have heard it said that the house of tomorrow will be largely welded steel homes with all the advantages of fire-safe construction. You have read many articles forecasting the prefabricated house as

BENNETT CHAPPLE

the economical answer to the high cost of shelter. There is evidence that these predictions are backed by a lot of sound reasoning. The American Rolling Mill Company as one of the largest manufacturers of iron and steel sheets has been much interested in the possibilities of this development. We have been glad to give encouragement and the benefit of our experience to engineers and builders working on the problem.

This active, rather than passive acceptance of the new trend, has been embarrassing at times, for it has given the impression that ARMCO is itself building steel homes for the public. This is not the case. ARMCO is working closely with all the different fabricators and is trying to share its helpfulness in every direction. We believe in the possibilities of a tremendous tonnage in the new field. If this tonnage materializes it means, too, a substantial increase in the welding industry, for the welding machine is to the sheet metal fabricating world what the sewing machine is to the textile world.

Yes, welding is playing an important part in the fabricating of metal houses. The frameless steel construction used by the Insulated Steel Construction Company, of Cleveland, presented some unusual problems that now seem to have been solved. To get the picture it is first necessary to understand the construction. Twenty gage sheets are used throughout the house for load-bearing walls and floors. These are spot welded in sections suitable for erection on the job. In light structures these sections are put together with metal screws. In heavier structures with heavier metal, such as store houses, these sections are arc welded in the field. The acetylene torch is used to cut openings for plumbing and heating vents.

The floor section is made up of "Z" shaped sheets each lapping the other, making a continuous span of metal boxes 8" wide by 5½" deep. This requires two welds, one each on the top and on the bottom, made simultaneously as the material travels through the machine. To add to the complications the welds are offset and the resistance has to travel through the 5½" 20 gage web without burning. John Skove, engineer of the Insulated Steel Construction Company, worked out the successful operation through the resistance welding process with low voltage and high pressure at the point of contact. Air cylinders are used to get approximately 1200 pounds pressure at the point of contact. The pressure is on a brief second for each double weld, and the current is applied one-third of this time. The same welding machine is used for the wall sections. Here, however, the resistance travels through a 2" double web with the metal sheets touching, and why the web does not arc and burn is one of the unexplained mysteries of electricity. The stock is run of mill with scale unremoved and is oiled, but this has not seemed to interfere with successful welding.

The machine was built by the Federal Machine and Welder Company for the Insulated Steel Construction Company. Such development in welding is making possible new avenues of service in the house fabricating field and promises an expanding market for the business of welding.

Welded Steel Products

By F. L. LINDEMUTH
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Youngstown, Ohio

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Abstract of paper to be presented at A. I. & S. E. E. Annual Convention in Pittsburgh, October 17 to 19, 1933.

This paper will discuss some of the questions which come up in the every day operation of what is called for want of a better term, a jobbing welderie.

In the older arts of construction which employ

castings, forgings and riveting, the possibilities and limitations of the manufacturing processes are known to persons using them, economical and satisfactory details of design and construction have been worked out by long experience, and tools and other equipment have been worked out to handle these details with a high degree of economy. To the person familiar with these manufacturing details a well designed and well built piece of equipment has a satisfying and pleasing appearance.

Welded construction is comparatively new and in a stage of development. With this new kind of construction only two new kinds of tools have made their appearance, the welding machine and the flame cutting machine. Other machinery used is that which was developed for other kinds of construction. The best ways of doing various kinds of work will be evolved through a period of cut and try, and when these best ways have been determined, if new tools are required they will be forthcoming. Until we become more familiar with this new method of construction we may be dissatisfied with its appearance because it is not what we have been used to.

Welded construction is justified when it is as good as and costs less than other construction, when it costs the same and is better, or when it has certain advantages which no other construction has.

To get the best results we should not try to make it exactly like something in which the method of manufacture or the qualities of the material was a large factor in determining the shape, proportions and appearance of the product, but should consider the properties of the materials used and the special advantages of the method of fabrication. Cast and forged details can often be used to advantage. If the job is well designed and constructed, the appearance should be pleasing.

The tendency is to use too much rather than too little weld material. The joints and connections are inconspicuous compared with most other kinds of construction, and the great strength of welds is therefore not always appreciated. The cost of the deposited metal is high. For hand welding it will run between fifty cents and two dollars a pound depending on the class of work. An excessive amount of welding will run the cost up very rapidly.

There are stresses set up in the weld metal during solidification and cooling which must be considered. One way to relieve these stresses is to peen each layer after it has cooled. This requires skill and judgment on the part of the operator. A more satisfactory method is by heating the finished job in a furnace, a kind of annealing or normalizing process. Proper stress relieving certainly improves the strength of a good weld, but is not always necessary. In some instances there are chances of damaging the work which more than offset the benefit which would be obtained by relieving the stresses. No definite rules can be given as to what kind of work should be stress relieved and how. The "fors and againsts" must be considered for each job.

Photographs of several kinds of work will be shown and the reasons for the details of construction explained.

F. L. LINDEMUTH

Welding and The Steel Industry

By A. E. GIBSON,
Vice President, The Wellman Engineering Co.,
Cleveland, Ohio

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Abstract of paper to be presented at A. I. & S. E. E. Annual Convention in Pittsburgh, October 17 to 19, 1933.

Mr. Gibson is a graduate of the Mechanical Engineering Department of Ohio State University, and has spent all but two and a half years of the last twenty-four with the Wellman Company. Starting as an apprentice, Mr. Gibson became Superintendent of the Cleveland Works two years after leaving college, and has held the offices of General Superintendent in charge of production of the Cleveland and Akron Works, Works Manager, and his present position of Vice President in charge of works and engineering production. He is also a director of the Company.

The Wellman Engineering Company, formerly The Wellman-Seaver-Morgan Company, has for many years been engaged in the manufacture of steel mill and special equipment. In addition to car dumpers, ore unloaders, coal and ore bridges, gas producers, coke oven machinery, skip hoists, and charging machines, they have built such outstanding equipment as the 250 ton sea-going floating crane, the Craneship "Kearsarge"; they designed the 500 ton capacity floating gate lifter for the Welland Canal, and recently the 160-ft. telescopic mobile mooring masts for the Lakehurst, N. J., and Sunnyvale, California Air Fields.

Being thoroughly conversant with production problems in the building of large mechanical equipment, Mr. Gibson brought to the company's engineering department the knowledge of shop and

A. E. GIBSON

service problems which has played an important part in the design of welded equipment.

Twelve years ago the Wellman Company's first venture into welding was made as the result of an effort to find a way out of the difficulty which confronted them in the failure of cast steel gas producer top plates to withstand a high temperature on one side, water cooling on the other, and strains both from expansion and external sources. The venture was a success, and since that time an increasing amount of mechanical details have been changed from cast to welded construction.

In many cases, increased strength of welded equipment was the principal reason for the change. In some, it was lighter construction. In many other cases, the change was made solely from the commercial standpoint of securing a less expensive product. In no case has service been sacrificed for cheaper construction, and in many instances all the advantages of light weight, increased strength, decreased cost, and saving in time, have been obtained.

This address will deal with Mr. Gibson's ideas of the part which the steel industry should play in the advancement of the art of welding in the fabrication of mechanical equipment. It will impress upon engineering staffs the importance of their part in the building of welded steel mill equipment and the need for rigid requirements covering the procedure of welding in order to insure best results.

Illustrating Mr. Gibson's talk, will be a number of lantern slides of typical welded equipment built by The Wellman Engineering Company. Many of these will show actual equipment used in steel mills, and will tell the story of its design from the standpoints of decreased weight, increased strength, decreased cost, and saving in time.

Fabricated Roll Steel

By LLOYD JONES

▲ Abstract of paper to be presented at the A. I. & S. E. E. Annual Convention in Pittsburgh, October 17 to 19, 1933.

So much has been published within the last few years, with reference to the substitution of welded roll steel for castings, that the writer has been somewhat puzzled as to what could be presented which would be novel and interesting.

It has been demonstrated by an almost endless number of examples in every shape and form that Fabricated Welded Steel can be substituted for castings advantageously in regards to strength and economy. The Engineer and Designer is rapidly learning how to select and assemble to the best advantage, the materials as rolled at the present time. The majority, however, still lack the faculty of shaping the materials so as to secure a pleasing and attractive appearance. This probably may be due to the fact that the rolled materials most used have been plates and slabs welded together in various forms. These two materials work out very well for frames, box sections, etc. A good example of this kind of construction is illustrated in Figs. 1 and 2. It is a 1500-ton, four crank press. The size of the

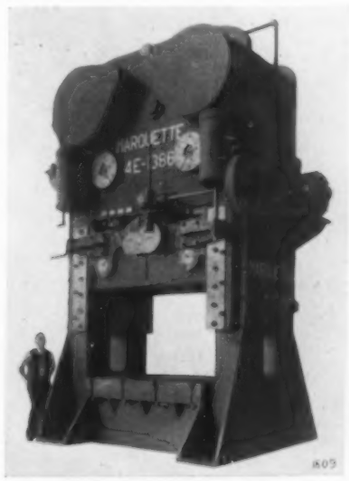

FIG. 1

machine can be judged from the man alongside. The frame work of the machine, exclusive of platens, gears, etc., weighed approximately 100,000 pounds and was annealed after completely welded. The machine was designed and built by a subsidiary of the E. W. Bliss Company and was tested to 1700-ton capacity without showing any noticeable deflection.

To appreciate the progress made in designs of welded steel construction, it is only necessary to study the outlines of this machine and compare it

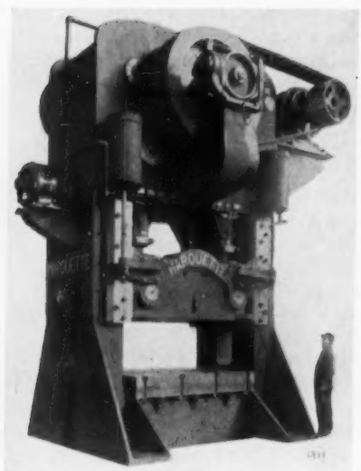

FIG. 2

with the machines formerly produced made of iron castings.

As stated before, the two principle roll products used were plates and slabs. It is about time for the Steel Manufacturers to assist the Machine Designer in other methods than merely by spurring him on with advice and propaganda. For the Railroads, the Bridge Builder and the Architect, they have produced a number of roll sections, especially adapted to facilitate design and construction. The Machine Designer in looking over the various rolled shapes in many cases, had to pass them to one side and resort to bending and shaping the plates.

In order to further the development in the use of Fabricated Roll shapes, the writer thinks a committee should be appointed and certain roll shapes developed or modified, so as to produce sections which can be used in machine design with the least amount of welding, cutting and bending.

Electrical Features of Modern Cold Roll Strip Mills

By A. F. KENYON
General Engineer, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

Abstract of paper to be presented at the A. I. & S. E. E. Annual Convention in Pittsburgh, October 17 to 19, 1933.

A. F. KENYON

The equipment and process for the production of steel strip by cold rolling, have undergone continuous development during the half century in which cold rolling has been actively practiced. The developments and improvements in mill equipment by the mill builders, and in rolling and treating processes by the mill operators, have been accompanied by important developments in the electrical drive equipment by the electrical manufacturers. The electrical developments are no less notable than those concerning the mechanical equipment and operating procedure, and the successful performance of modern cold roll strip mills, operating at delivery speeds up to 1200 F.P.M. and producing stock down to .006" thick, up to 72" wide, and in coils containing several thousand feet, depends to a considerable extent upon the special characteristics of the mill and reel motors, and the smooth functioning of the control equipment.

During the last few years, the cold rolling process has been extended to the production of strip material from 28" to 36" wide and from .006" (38 gauge) to .011" (30 gauge), used for tinplate. Three distinct types or arrangements of the mill equipment have been developed and are in use producing this size and grade of strip.

A—Tandem Mills:

Tandem cold roll strip mills consisting of four or occasionally five roll stands and a tension winding reel following the last stand, have been in general use for many years. Improvements in mechanical and electrical control are permitting operation of such mills at increased rolling speeds, and speeds of 600 F.P.M. or higher from the last stand are considered feasible. The successful rolling of wide thin strip requires smooth acceleration and deceleration to avoid breaking the thin strip, and such smooth operation is provided with proper variable voltage control. It is also necessary to maintain the strip under moderate adjustable tension between stands, in order to keep the strip centered in the

mill and avoid wrinkling, and a number of methods for such tension regulation have been developed and applied.

B—Single Stand Reversible Mills:

A type of cold mill now coming into extensive use for producing tinplate and other wide light gauge strip, consists of a single, four-high, roller bearing, roll stand, of extremely heavy and rigid construction, together with two winding reels arranged one on each side of the mill. The entire equipment is made reversible, so that the strip may be unwound from one reel, passed through the rolls, and rewound on the second reel; the mill is then screwed down, the direction reversed, and the strip is unwound from the second reel, passed back through the rolls, and rewound on the first reel; this reversible rolling process being continued for from three to seven passes.

Motors are provided on the mill working rolls and on each of the two reels. During operation the larger part of the rolling power is supplied by the motor driving the mill rolls, and a smaller part is supplied by the motor driving the winding reel. The motor connected to the unwinding reel operates as a regenerative braking generator to maintain a back tension on the strip entering the mill.

The reel motors are of quite large capacity to provide the tension necessary during the early passes when the strip is heavy, and extremely accurate and sensitive control is required to regulate and limit the tension during the later passes to avoid breaking the thin finished strip. To reduce the reel drive inertia to a minimum, special reel motors with small diameter long core armatures are used, and the control equipment provides means to compensate for the remaining inertia during acceleration and deceleration in order to maintain the strip tension as nearly constant as possible.

C—Steckel Mills:

Steckel mills provide the single stand, reversible operation similar to that just described, except that the mill working rolls are not driven, and all of the rolling power is applied by the winding reel through the tension in the strip, so that the strip is pulled through the die rolls by the winding reel. The reduction which can be made is limited by the strength of the strip, so that a larger number of passes is required to effect any given total reduction. However, it is claimed that the lighter reductions assure finished strip of more accurate and uniform gauge, and the loss in tonnage output due to the greater number of passes is partially offset by the higher speeds at which the Steckel type mills are operated.

The usual mill arrangement provides a single main motor, of about 1000 HP. capacity, which, by means of mechanical clutches, may be connected to either of the two winding reels, to pull the strip back and forth through the die rolls. On the earlier mills, the necessary back tension was provided by a friction brake on the unwinding reel, but more recently an electrical regenerative braking system has been developed, and a mill using it is now being installed. The electrical braking system eliminates the considerable expense of maintaining the large friction brakes, permits a worthwhile reduction in the energy consumption because the regenerated braking power is recovered and used to help drive the winding reel, and makes the back tension readily adjustable at the will of the operator to meet variable operating conditions.

Reduction Gear Sets In Connection With Main Drive Mill Motors

By AUSTIN KUHNS
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Abstract of paper to be presented at A. I. & S. E. E. Annual Convention in Pittsburgh, October 17 to 19, 1933.

Because of the breadth of this subject my remarks will be confined to a survey of the factors which are involved in the installation of gear reduction sets for use with main drive mill motors. In this connection I shall discuss, as concisely as possible, those details which pertain to the actual installation and operation of the reduction units, and to the developments which we can see ahead of us at this time.

AUSTIN KUHNS

We have always recognized the importance of lubrication but we have never realized to the fullest extent the scope of its influence on the performance of gear sets. Today we know that many of the pe-

culiarities which we have observed in the operation of these units are produced by the conditions of lubrication, some of which can be diagnosed, with others as yet far from being understood.

The attention of many technical societies is focused today on the problem of standardization of lubricating compounds and the simplification of their selection, expecting thereby to reduce the wide difference between their effect on wear, mechanical efficiency, temperature, noise, vibration, maintenance, and the working life of a gear drive.

Of equal importance to the selection of the lubricating compound is its application to the areas of pressure, or contact. Experience has shown that the various types of circulating equipment are of excellent design, but the necessity for careful control over the temperature and purity of the lubricating compound has introduced certain new features.

With the possible exception of the anti-friction bearing, there cannot be metal to metal contact at the points or areas of pressure in either the meshing gear teeth or in the bearings. Upon the strength of the lubricating film, therefore, depends the effective use of materials selected. The success which has been experienced with hardened steels, and the extent to which they are introduced in present designs justifies a more than passing attention to the subject of the film strength of lubricating compounds.

During the past decade the technique in manufacture of gears and reduction units has developed to the point where it is difficult to realize the accuracy and the precision with which the different pieces are machined. This continued improvement will go on, but more noticeable in the next few years will be the improvement in the materials which will be used. In fact, there is available today for the designing engineer a host of specialties in the irons and steels and, in addition, there has been introduced the effective use of steel plate and rolled sections, and the heat treatment of those parts where special characteristics are desired.

A timely item for more detailed discussion is the overall efficiency of reduction gear sets. The large number of factors which contribute to the frictional losses preclude the practicability of a mathematical treatment of this subject, but there is available considerable information based upon the experience and observation of actual installations. Co-incident with the efficiency of the gear unit, and with its lubrication, is the peripheral speed of the gear teeth, the characteristics of the bearings, and also the power to be transmitted.

In my remarks, of course, I shall introduce many other factors which contribute to the successful mill drive, such as power ratings, overload capacities, ratios—both single and double, standardization, etc., and finally I shall call attention to the importance of the gear set as a convenient and inexpensive medium for obtaining any desired roll speed with the use of standardized electrical equipment.

G. A. MERKT

Recent Developments In Design and Operation of Industrial Furnaces

By G. A. MERKT
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Abstract of paper to be presented at A. I. & S. E. E. Annual Convention in Pittsburgh, October 17 to 19, 1933.

After briefly reviewing the essential features which have entered into the construction of fuel fired furnaces up to the present, the author dwells upon the consideration of the combustion process and its relation to furnace work in the light of more recent understanding. The importance of the "Thermal Equilibrium" of the furnace is pointed out, going into an examination of the opposing factors which must be balanced for ideal maximum capacity. It is shown that it is not enough to translate the potential heat energy in the fuel into heating capacity, but that the speed with which the combustion process proceeds and the ensuing flame temperature are of vital influence in procuring the desired furnace operation. The relation of emissivity to combustion speed and flame temperature is discussed, also the means available for adjusting or controlling these

properties of combustion. An approximate comparison of several fuels and their respective combustion values in connection with the foregoing considerations is offered for study, indicating the range of manipulation available to condition the fuel, or rather its combustion, so as to suit it economically to the limitations and requirements of the furnace.

Finally, the author introduces a novel Combustion Conditioning Process and apparatus, the functions of which are based upon the fundamental contemplations brought forward in the paper. This Combustion Conditioning System is applicable to the reversing or regenerative type of furnace construction as well as to the continuous type or one-way fired furnace, adaptable not only to large units, but also to very small fuel consumers, and is distinguished by striking simplicity.

The paper endeavors to direct attention to need for giving these known characteristics of combustion and heat transfer due consideration when comparatively rich fuels are used in the furnace, particularly the by-products of the Coke and Oil industries and the natural gases.

Recent Developments In Cold Strip Mill Electrical Equipment

By F. MOHLER
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Abstract of paper to be presented before A. I. & S. E. E. Annual Convention in Pittsburgh, October 17 to 19, 1933.

Within the last year a great many improvements and developments have been made in the electrical equipment used with cold strip mills. The majority of these have been brought about by the requirements of the reversing cold strip mill.

This mill consists essentially of a 4-high precision stand of rolls, a reel on either side of the mill for alternately winding up and unwinding the strip, and idler rolls for maintaining the same pass line. The ends of the strip are clamped in the reels and the mill is run first in one direction and then in the other. After each pass the screws are adjusted so as to make the proper reduction.

The mill and each reel are driven by separate adjustable speed d-c. motors.

The adjustable potential system of control is used so as to obtain the necessary smooth acceleration and deceleration of the mill.

F. MOHLER

There is a variety of combinations of electrical machines, depending upon the requirements.

It is possible to use a common generator for the mill and reel motors when the reel motors can be built with sufficient field controlled speed range to cover that of the mill motor, the coil build-up, and the margin required for the regulator. Otherwise part of the speed range must be taken by armature voltage and a separate generator used for the reels. This generator is controlled so as to make the voltage applied to the reel motors proportional to the strip speed at all times.

Drafts as high as 50 per cent are contemplated which means, of course, that the unwinding reel rotates at one-half the speed of the winding reel, for the same coil diameters. Now, back tension is maintained by operating the hold-back reel as a generator and it would be necessary to double the excitation to obtain a voltage as high as that of the reel or main generator. This, however, would double the required speed range of the reel motor which is impractical. This boosting voltage, to compensate for draft, is therefore obtained from an auxiliary generator. It is obvious that every time the draft changes the voltage of the boosting generator must change in proportion.

Constant tension, even during acceleration and deceleration, both front and back, is extremely important if constant gauge and quality is to be obtained.

The usual tension regulator maintains tension by maintaining a constant input current to the reel motor. Thus during acceleration the total current input must be increased by the amount necessary to accelerate the reel drive, and vice versa during deceleration. The reversing cold strip mills, thus far, have involved rather large reel motors—from 500 to 800 hp.—with a relatively high inertia. Thus, if no attempt is made to compensate for the current required to accelerate, the tension maintained will vary over a wide range. Furthermore, if the regulator is merely arbitrarily set to hold a definite higher current for a certain period of time, it is not

only a very rough compromise, but offers difficulties of overshooting, etc., during the period of transition.

If the forcing of the regulator offers a problem in connection with the winding reel, it is doubly important with the unwinding reel. The usual back tension is only 10 to 50 per cent of the pulling tension. Thus the current required to accelerate becomes a much greater percentage of that being maintained by the regulator. In fact, the amount of forcing may be so great that it is necessary for the pump back current of the unwinding reel motor to be reduced to zero and actually reverse so that it operates as a motor during acceleration. It is obvious that with the usual current regulator such operation cannot be obtained.

To meet these requirements a regulator has been developed which not only "forces" in proportion to the rate of acceleration at all times, but will actually allow motor operation of the unwinding reel motor during acceleration.

Where very low back-tensions are required it becomes necessary to disconnect the unwinding reel motor and use a small drag generator.

During the transfer from one direction of rolling to the other it is necessary to disconnect the reel motor armature. Thrustor brakes are used to keep the coils tight during this period.

Semi-automatic pre-set screwdown control has been applied to this type of mill whereby it is possible for the operator to set his next pass screw position while he is rolling one pass. Then at the end of the pass he merely presses a button and the screws go to the selected position without further attention from him.

Pratt and Whitney Continuous Electric Gages have been applied for not only indicating and recording the strip thickness continuously, but for use with automatic control whereby the screws are adjusted if the tolerance limits are exceeded.

An instrument involving the use of Selsyns has been developed for indicating the percentage draft at all times.

New generator field control, giving extremely smooth acceleration and deceleration, as well as preset control of the threading and running speeds has been developed for adjustable potential tandem and single stand cold strip mills.

Pack and Pair Heating Furnaces In Connection With Sheet and Tin Mills

By R. J. WEAN
President, Wean Engineering Company, Warren, Ohio

Abstract of paper to be presented at A. I. & S. E. E. Annual Convention in Pittsburgh, October 17 to 19, 1933.

R. J. WEAN

In looking backward—which is the direction one must always look for mistakes—it is difficult to understand why Sheet and Tin Mills were not long ago offered more adequate heating facilities in the form of Continuous Heating Furnaces for Heating Pairs and Packs. Modern Continuous Pack and Pair Heating Furnaces are quite a recent development; and, like all other innovations, received considerable resistance from the producers until it was demonstrated that the heating from these modern units was far superior to the results obtained from the older type furnaces.

The heating results have been exceptional and have permitted tonnage production from single stand units far in excess of anything ever considered possible. Where a finishing stand formerly produced five or six tons of light gauge sheets in eight hours, the heating facilities new permit thirty tons in eight hours of the same gauges, and in many instances peak productions are much higher.

During the early stages and introduction of Continuous Furnaces in the Sheet and Tin Mills, the general furnace situation was beclouded with many irrelevant statements and prejudiced opinions. Importance was attached to types of fuel that later developments proved entirely unfounded.

Continuous Furnace development started with the firing of raw producer gas, progressed through the stages of washed producer gas, natural gas, coke oven gas, light oil, back to raw producer gas and now to the use of heavy oil. All of these fuels are being used in the production of various grades of material with satisfactory results.

The Sheet and Tin Mill that wishes to give con-

sideration to furnaces should survey the available fuels and space for the installations. If there is some question as to the availability of a single fuel on a price basis that would be favorable, it would be advisable to consider equipping the furnace with a dual fuel system, i.e., oil and natural gas. This can be done with little extra expense and places the producer in the very favorable position of being able to shift to the lower cost fuel at any time.

In the final analysis, there are two things of major importance to the producer; first, quality of heating and, second, lowest ultimate cost. Some of the producers have a third problem which is that the equipment must be capable of handling a wide variety of sizes, gauges and finishes. It is not unusual for a mill to have scheduled electrical sheets, enameling stock, common black sheets, single pickle and full finished, these to go through the same furnace and to be rolled on the same mill within 24 hours. Needless to say, if this producer has a single purpose furnace he is in a very unfortunate position as either he can not roll some of the materials mentioned or he will obtain very mediocre results and probably a very high scrap loss. This third requirement of flexibility has removed the furnace from the realm of burner and conveyor design to one of utility, and it requires a thorough knowledge of sheet and tin mill practice for the design of such a furnace.

Electric Furnaces For Annealing Strip and Sheets

By A. N. OTIS
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▲

Abstract of paper to be presented at A. I. & S. E. E. Annual Convention in Pittsburgh, October 17 to 19, 1933.

The paper will describe several installations of electric furnaces for annealing cold rolled strip, silicon steel sheets, and silicon steel strip, and will outline several new designs which have been worked out for bright normalizing and annealing of sheets, bright annealing of wire and tubes, also equipment for producing the necessary atmospheres for these furnaces.

Some of the specific subjects to be discussed are as follows:

A. N. OTIS

Bell type furnaces for batch annealing of coiled strip, giving some operating data and outlining the results which may be expected from this type of furnace.

The rectangular bell furnaces for annealing silicon sheets provided with recirculating system for forced cooling, and discussing some of the requirements for furnaces for this purpose with regard to the nature of the atmosphere and its effect on the material at high temperatures.

Description and discussion of a continuous furnace with controlled atmosphere, recently installed for annealing of silicon strip.

Walking beam furnace for bright normalizing and annealing of auto body or similar sheets, provided with means to control the cooling rate. Such furnaces have been laid out for 120 tons output per day. They offer the possibility of eliminating the pickle after normalizing, and also for continuous annealing as a substitute for box annealing, greatly shortening the process time.

Roller hearth furnace for bright normalizing or annealing cold drawn steel tubing.

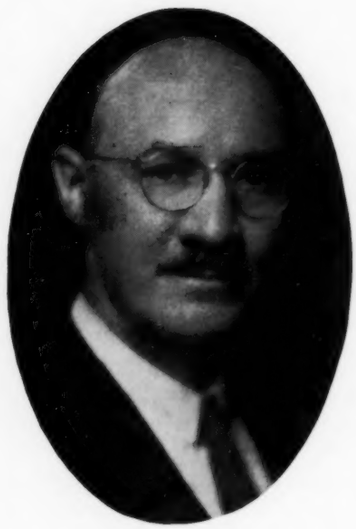
Bell type furnaces for bright annealing steel wire.

Modified bell type furnaces for non-scaling anneal of steel wire.

Atmosphere producing equipment for supplying the atmosphere to the furnaces described, and for box annealing.

It will be noted that all of the furnaces referred to employ protective atmospheres, and developments now point to an extensive use of these types of furnaces in the steel industry.

Controlling Screw-Down Drafts To The Exact Specifications of The Mill Superintendent



D. C. WRIGHT

By D. C. WRIGHT
Chief Engineer, The Electric Controller & Mfg. Company, Cleveland, Ohio

▲

Abstract of paper to be presented at A. I. & S. E. E. Annual Convention in Pittsburgh, October 17 to 19, 1933.

Why do mill engineers and metallurgists devote so much time to study of the proper amount of draft for each size of ingot or billet rolled in the Blooming Mill?

Are these drafts, or the rolling specification, accurately followed by the screw-down operator, when, in most cases, the whole responsibility is left up to his intelligence, strength and skill?

Improper drafts, especially on the first few passes, damage the quality of the steel or cause seams and cracks that require chipping before final rolling. Chipping is practically needless if the ingot is rolled to the specifications given by the metallurgist.

To insure that these specifications are adhered to, the "personal element" of the operator must be eliminated.

The only way to accomplish this, is to provide automatic control of the screw-down motor by means of a pre-set controller, making the operator responsible only for starting the motor for each pass at the proper time, but not for stopping it.

An automatic pre-set screw-down controller will be exhibited at the Fall Convention, suitable for a 54" blooming mill, providing 863 possible stopping points at 1/16" minimum movement, 11 or more pre-set passes, instantaneous change of schedule for 4 or more different sizes of ingots or billets, quick set-up for any new size, and instantaneous change to manual control in case of emergency, with immediate change back to automatic control when the emergency ceases. The operator simply pushes a single operating button repeatedly for each pass—the controller takes care of the stopping—accurately—regardless of distance of travel or amount of draft—regardless of direction—and in proper sequence from first to last pass.

New, green operators (NRA operators), should give better results with automatic control than seasoned operators with manual control—accuracy—less than plus or minus 1/32" of the scheduled position. No inching for proper position required. Proper size of finished product turned out.

New scheme of vernier cutout where a 12" diameter cutout gives same accuracy as a 24-ft. diameter cutout.

A new plug-in scheme giving any one of 863 stopping positions by adjusting two plugs only.

Only five wires run to the mill itself, with only one piece of apparatus mounted on the mill—a small motor.

If used on a sheet mill screw-down with ¾" total travel a minimum of .001" travel is secured.

By addition of a second vernier, control over 92-ft. travel is available at 1/16" minimum movements or 17,664 possible stopping positions are permissible.

Rolled Steel Products In Electric Locomotive Construction

By R. V. DEVLIN
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Abstract of paper to be presented at A. I. & S. E. E. Annual Convention in Pittsburgh, October 17 to 19, 1933.

This paper is an endeavor to show, in a general way, the manner in which rolled steel products are applied to electric locomotive construction and particularly to construction wherein the fabrication is

R. V. DEVLIN

by means of arc welding. It will deal with locomotives as built for mine and industrial service only and will be restricted to locomotives manufactured by the General Electric Co.

Prior to the advent of arc welding, sheets and strucural shapes such as angles and channels were used for cabs and under-framing. Fabrication was, of course, accomplished by means of rivets and bolts. The limitations of rivet and bolt construction are rather well defined, so that certain elements of the mechanical structure such as end sills, draft gear, housings, truck bolsters and other similar parts of irregular shape and contour were necessarily made of castings or forgings. The arrival of arc welding (and some years before that the flame cutting tool) gave the locomotive designer a much greater freedom of choice and gradually those component parts which had been castings or forged shapes were supplanted by structural steel shapes and plates fabricated into an integral whole by arc welding.

Beginning with the welding of minor items—contactor supports, cable supports and similar details—the practice was gradually extended until in 1924, a 30-ton battery switching locomotive was built with the entire super-structure; that is, cab and under-frame of all welded construction. The trucks, however, were the conventional arched bar type. Finally, in 1931, a fleet of seven 55-ton Diesel electric switching locomotives were built with the entire mechanical portion, including the trucks, constructed of structural shapes and plates and fabricated throughout by arc welding. There were no rivets whatever and bolts were used only for those portions requiring occasional renewal or removal.

While these locomotives exemplify the most complete and outstanding application of rolled steel products to locomotive construction, and were made possible by the development of arc welding, the introduction of flame-cutting some twenty years ago brought about, from a tonnage standpoint, a much greater consumption of rolled steel.

Prior to 1910, mine locomotive frames were made of cast steel. As a material, this was entirely satisfactory but to meet the widely varying local conditions prevalent in the mining industry, very frequent departures from standard wheel base and overall dimensions were necessary and the continual development of new frame patterns imposed a rather severe burden on manufacturing cost. With the coming of an oxygen-acetylene cutting flame, cast steel was discarded and the side frames were cut from solid rolled steel slabs. Depending upon the size of the locomotive, the slabs ran from 2" to 6" in thickness and although the machining labor was somewhat increased, the wide price differential between rolled and cast steel more than compensated for it. Moreover, pattern charges were eliminated, and the development of a new side frame was then merely a matter of a new drawing. Steel castings are still retained for mine locomotive end frames because, in general, the shape and contour does not lend itself readily to fabrication, but even here, the arc weld has made it possible to fabricate satisfactory end frames and such frames are being made in cases where only one or two sets are required and patterns do not exist.

Steel castings will, quite likely, still continue to be a factor in locomotive construction but they do not, as heretofore, impose restrictions on locomotive design; and since the building of this class of locomotives requires so many departures from standard dimensions and so many special features, arc welding has supplied the proverbial "long felt want."

Growth of The Electric Arc Welding Industry

By E. A. HURME
Engineer, Clark Controller Company, Cleveland, Ohio

To be presented at the A. I. & S. E. E. Annual Convention in Pittsburgh, October 17-19, 1933

Of all the processes, developments and improvements that have affected the Steel Industry during its long history, one of the relatively recent ones is possibly as fundamental in its nature, as revolutionary in its effect and as far reaching in its results as any on record; namely, the process of electric arc welding. When we remember that only twelve or fifteen years ago it was little more than an artisan's process for repairing broken machinery and other metal parts and that today, it is a basic industrial factor in the production of automobiles, heavy machinery, steam boilers, pipes, tubes and general steel commodities, we begin to get a better understanding of its tremendous importance to the Steel Industry.

So much has already been said about arc welding, so many fantastic claims have been made for it that many individuals are today skeptical, if not openly scornful about the supposed advantages of arc welding. Therefore, it seems worthwhile that we make a more critical and more technical investigation of the subject with a view to understanding what actual progress has been made in arc welding,

E. A. HURME

what really can be done with it and what its probable future is.

Welding Rods:

To deposit weld metal possessing qualities identical with or exceeding the parent metal has been the ultimate aim of electric arc welding rod development. For many years after its inception, electric arc welding implied the use of ordinary bare steel wires. After the electric arc welding process came into more general use, flux coated welding rods were introduced and now coated electrodes of a highly complex nature, for wide and varied applications are on the eve of common acceptance.

In the hands of a good operator excellent welds can be made with bare rods. One of the big disadvantages to the use of bare rods, however, is in the lack of surface uniformity which affects the arc characteristics and in turn the weldability qualities of the welding rod. It is for these reasons that a rapid increase in the use of welding rods with carefully controlled coatings, for all classes of welding, is taking place, thus providing greater uniformity in both arc characteristics and improved quality of the weld metal produced.

The significance of this change is shown by the fact that, while in 1927 approximately 85% of the electric arc welding was done with bare rods, in 1932 bare welding rods constituted considerably less than 25% of the total consumption of electric arc welding rods.

Bare welding rods have had and still have their place in the development of industrial welding and for many applications they produce satisfactory results. Welds made with bare rods may exceed the parent metal in ultimate strength and be sufficiently dense to meet some pressure requirements. Such welds, however, are greatly inferior to the parent metal in ductility, resistance to corrosion, fatigue and impact stresses and generally show considerable porosity. Welds made with bare rods may have an elastic limit greatly exceeding the parent metal. This fact, in combination with a satisfactory tensile strength, enables their successful use in fabricating many light, flexible structures. In such cases, the parent metal having a lower elastic limit than the weld, will distort without causing weld failure. In the welding of heavy rigid members a different condition is introduced; namely, higher rigidity due to a greater section modulus. In such heavy structures the parent metal resists distortion and the weld metal must be sufficiently ductile to absorb the stresses set up by its own contraction in cooling down after deposition. Because of its lack of ductility, bare rods have not been successfully applied to the welding of heavy structures.

Welding With Bare Rods:

Welds made with bare low carbon steel rods have rather low ductility due to the absorption of oxides and nitrides from the surrounding air, which are exceedingly active chemically at the melting temperature of the welding rod. The extremely high temperature of the arc (estimated at 3700 deg. C.) is a contributing factor to this condition of contamination since the absorption of oxygen and nitrogen increases rapidly with the temperature. The transfer of metal from the rod to the work is thought to take place in the form of minute pellets and in this divided form the conditions are especially conducive to contamination.

The combination of extremely high temperature and relatively large surface area of the metal which passes through the arc, with bare welding rods, readily permits chemical reactions between the oxygen and nitrogen of the atmosphere and the elements of the molten metal. Oxidation and partial elimination of the carbon and manganese of the weld metal occurs, and, at the same time iron and possibly manganese nitrides are formed and absorbed in the molten metal. The amount of these inclusions depends upon the current used and the length of the arc.

The length of the arc is therefore an important factor in governing the quality of the deposit made with the bare mild steel welding rods. The skillful operator using bare welding rods generally selects a small size, uses low amperage and holds a short arc. For quality work with bare rods, the operator is thereby limited to low production rates.

When welding with bare rods, iron and manganese oxides are absorbed. Also many of the gases formed are unable to free themselves during the rapid freezing of the molten weld metal. It is the presence of these elements in the weld metal, made with bare rods, which impairs its strength, causes low ductility and low resistance to corrosion, as well as low impact strength.

Comparisons of bare rod deposited weld metal analysis with the analyses of the original bare rod show that the carbon content has been reduced to a negligible amount, that the manganese content has been materially decreased and that a great increase in absorption of oxygen and nitrogen has taken place.

Surface Conditions:

It has also been established that surface condi-

tions of the welding rods have a greater effect on the quality of the welded joint than any other single factor.

In the bare wire electrodes used for electric arc welding the residue of lime, iron oxide and other impurities left on the surface during the wire drawing process is a decided advantage in increasing the arc stability and as these impurities float off the molten weld metal, they do not affect the quality. In fact, in all bare wire electrodes, the arc characteristics depend very largely on the hit-or-miss form of coating placed on the surface during the drawing operations.

On the basis of these and other findings, the arc welding industry has made tremendous progress in that it has developed a variety of specialized welding rods, which make possible the fabrication and construction of structures, machines and commodities from many grades of steels and alloys, thus opening new fields of application.

Let us examine more carefully just what these specialized welding rods are and what they can do.

Since it is well known that the surface conditions or materials on welding rods have such a great affect on the welding procedure and the resultant weld, it is not surprising to find that most specialized welding rods are surface treated, coated or covered with substances to give some definite benefits.

The surface coating materials are usually nonmetallic, although they may contain metallic elements and affect the characteristics of the electric arc in one or more of the following ways:

1. **Stabilizing Coatings:**

Stabilizing coatings tend to stabilize the electric arc by supplying materials readily volatile below arc temperatures and thus, to a limited extent, they produce a neutral or slightly reducing atmosphere surrounding the arc stream, thus reducing the oxidation of the incandescent metal and thereby improving the quality of the deposited weld metal. This class of coatings, however, should not be confused with the so-called shielded arc types described later.

Stabilizing coatings may also be applied to increase the depth of penetration for welding heavy parts or to reduce it for light gauge work.

2. **Deoxidizing or Purifying Coatings:**

Deoxidizing or purifying coatings deoxidize and may also purify the weld metal to a greater or lesser degree by reducing the oxides and nitrides in the weld. These coatings are generally metallic substances possessing greater affinity for oxygen and nitrogen than iron and, for that reason, readily unite with whatever oxygen is carried over into the weld metal to form a fusible slag which floats to the surface of the weld metal where it can be easily removed.

3. **Speed Coatings:**

The melting rate of a base rod may be increased two or three times without any harmful effects to the quality of the weld metal by adding special stabilizing materials to the coating so that the welding rod may operate with higher amperage and longer arc. With the increased melting rate, the welding rod carries the current for a shorter period of time and thus makes possible the use of higher currents without overheating the rod.

These speed coatings also cause the metal to pass from the welding rod to the work in fine particles so that the heat is always working on unmelted steel in the welding rod.

4. **Alloying Coatings:**

Due to the fact that weld metal is deposited in the form of a casting, its physical properties cannot be, to any appreciable extent, improved by mechanical working, such as rolling, forging, etc. To take the place of this mechanical working, suitable elements or alloys may be added in the coating to improve the physical characteristics of the deposited weld metal. These elements melt and unite with the base metal as they pass through the arc and directly govern the physical properties of the weld metal.

Several or even all of these various classes of coatings may be combined to produce a single grade of welding rod. In fact, by proper combination it is possible to give the user virtually any quality of deposited metal which the specific application required.

The surface coatings thus far described, tend primarily to protect the weld metal from contact with the air during the deposition period.

5. **Shielded Arc Welding:**

The latest and most far reaching improvement in welding—the shielded arc electrode—not only protects the weld metal from contact with the air during the transfer period and does it infinitely better but it accomplishes still more. In fact, with this new development, the deposited weld metal is of such excellent quality that it compares favorably with high-grade electric furnace steels.

Nor is this strange, because a shielded arc in operation actually is a miniature electric furnace insofar as its steel making characteristics are concerned. In the large electric furnace, high-grade metal is produced because atmospheric conditions are carefully controlled and because the ratio and quality of raw materials are definitely fixed and because the temperatures of melting and casting are held within rigid limits. In the miniature furnace, that is, in the shielded arc welding, the same conditions are maintained.

Shielded arc coatings are in reality extensions to the stabilized types enabling the arc to be surrounded by a heavy envelope of reducing gases which not only protect the steel passing through the arc from the action of the air, but also act as purifying agents and in this way reduce the oxides and nitrides in the weld metal to an extremely low value. This shield takes the role of the steel makers furnace enclosure where atmospheric conditions are under definite control. Furthermore, irrespective of arc length or current over rather broad limits, the welding

rod is melted and cast under controlled conditions resulting in high-grade steel.

In addition to higher tensile strength and ductility as well as the great increase in speed of welding, welds made with the shielded arc process have high resistance to corrosion. This is due to the density of the weld metal and the elimination of iron oxides from it.

Shielded Arc Welding Electrode Applications:

Shielded arc welding electrodes have three large fields of application; namely:

1. For the welding of rigid structures of all kinds where the high strength and ductility of weld metal is required, such as pressure vessels, boilers, machine bases, frames and pipe lines.
2. For high speed applications where reduction in production costs are important, such as low pressure storage tanks, boilers and heavy metal cabinets and containers, as well as many machinery parts where quantity production is involved.
3. For work where welds are subject to corrosive action such as refrigeration equipment and for parts used in outdoor and underground service.

Alloy Steel Welding Rods:

The welding rods discussed thus far are primarily for use with ordinary mild steels; but fully as great progress has been made in the field of welding alloy steels even though this field has presented many serious problems.

For instance, if a weld is made with a welding rod composed of a given alloy steel, the deposited metal, oftener than not, is found to have changed considerably in composition by its passage through the arc. Moreover, many alloys, when used as welding rod, have poor flowing characteristics, or in some other way seriously affect the operation of the arc so that their use is impractical.

And even if these difficulties did not exist, it would be impractical for steel mills to produce many of the alloy steel welding rods required for special applications.

But, since the electric arc is a miniature electric furnace, it provides an excellent method for introducing desired alloys in the deposited weld metal by incorporating them in the welding rod coatings. Thus the fundamental principles applied in the manufacture of electric furnace steels are similarly employed in the processes of manufacturing many coated alloy steel welding rods.

The steel maker starts with a known base and adds alloying ingredients or deoxidizers in proper proportions to produce a steel of a given composition. By varying these charges different steels are produced.

Likewise, in the manufacture of some makes of coated alloy steel welding rods, a known base metal having good arc characteristics is selected and to this base is applied, in the form of a coating, alloying ingredients or deoxidizers in pre-determined quantities. As stated before, the arc is a miniature furnace in which the alloying ingredients unite with the base metal. The parent metal is the mold in which the alloy is directly cast. The weld metal has definite physical characteristics controlled through the coating and the welding rod manufacturer varies the coating according to the weld metal requirements.

With this elemental steel making process at his command the welding rod manufacturer is able to match the composition of the material which is to be welded. In this way the working qualities of the welding rod and the entire characteristics of the weld metal may be changed at will by changing the character of the materials on the welding rod surface.

An interesting illustration which shows how the coating material may completely change the deposited weld metal is the case of high manganese welding rods made from low carbon steel base rod which is given uniform coating of alloy ingredients carefully controlled as to weight. To obtain maximum wearing qualities, manganese steel should contain from 10 to 15% manganese and about 1.25% carbon. A relatively slight drop below this range in the manganese content results in a considerable reduction in the wearing qualities of the metal.

It is a well known fact that in melting alloy steel there is a considerable loss of manganese and carbon and the skilled steel maker takes these melting losses into account in charging the furnace. Obviously, if the welding rod and the parent metal are of the same composition, the deposited metal will most likely be of inferior quality. Some of the welding rod manufacturers anticipate these losses by incorporating sufficient alloy ingredients in the coating. With the use of alloy coated welding rods, the welder is thereby able definitely to control his weld and deposit the best composition of high manganese steel.

The following simple demonstration proves that elements incorporated in the welding rod coating do alloy and mix with the base rod material: As you may know when a welding arc is struck, a bead of molten metal forms at the tip of the welding rod and then a series of small metal globules are projected across the arc to form the weld. Now in the case of a mild steel base rod with a manganese type coating, if the arc is broken and a magnet is applied to the globule of metal which remains at the electrode tip it will be found to be non-magnetic whereas the unmelted low carbon base rod immediately adjacent to the globule is magnetic. This clearly shows a positive alloying action occurring in each drop of metal before it leaves the welding rod and further illustrates how basic raw materials in pre-determined quantities are alloyed in the arc to produce a steel of specific characteristics. This same principle may be carried out in depositing many other types of ferrous and non-ferrous alloys. Welding rods which deposit metal of rail steel hardness, or tool steel hardness or metal highly resistant to corrosion or metal of high strength and ductility may have the same base rod of low carbon steel and differ only as to the coating ingredients.

The use of a low carbon base rod and a heavy alloy coating affords additional advantages in the actual welding process. For example, in welding high manganese steel it is advisable to keep the base or parent metal as cool as possible in order to avoid overheating of the parent metal. This is accomplished by the heavy refractory coating on the welding rod. It concentrates the heat at the welding rod tip so that it is possible to use a lower

current than is usually necessary with bare alloy rods of similar diameter. Furthermore, welders generally recognize that an alloy rod does not produce the same degree of arc stablity as a low carbon steel rod. By using a low carbon base rod and by introducing the alloying ingredients in the coating a greatly improved alloy depositing welding rod is obtained which closely approaches the mild steel rod in arc stability.

Comparisons of Weld Metal Characteristics:

Differences in weld metal characteristics between a test bar made with a high grade bare welding rod and a shielded arc electrode are shown in Table I.

TABLE I

Test Bar	Yield pt. lbs./sq. in	Ultimate tensile str. lbs./ sq. in.	% Elong. in 2"	% Reduct. of arc	Spec. Gravity	Brinell hardness
#1	46,300	58,000	6	16	7.51	179
#2	60,500	71,400	27	40.5	7.83	170

Test for #1 was made with a high grade bare, low carbon steel welding rod. Test bar #2 was made under identically the same welding conditions and the same kind of base rod was used only in this case the base rod was coated with a suitable shielded arc coating.

It will be noted that the yield point has been increased from 46,300 lbs. to 60,500 lbs., ultimate strength from 58,000 lbs. to 71,400 lbs. and the elongation from 6% to 27% in 2".

As stated before these two test bars were made, using the same bare welding rod stock and were welded under identically the same conditions, yet the results obtained are quite different, thus clearly indicating that proper surface coatings do improve the deposited weld metal characteristics.

Plates #1 and #2 show metallographically the differences in the deposited weld metals. Plate #1 covers test bar #1 while plate #2 shows the grain structure of test bar #2.

Butt Weld Made With Bare Electrode:

Perhaps the most striking feature of the polished and etched central section of Plate 1 is the presence of numerous holes in the weld metal. Some of these are due to arc conditions, some result from included gaseous matter and others are caused by oxidation of the metal after it has been deposited. It will also be observed that large, columnar macrograins have formed in the beads because of unfavorable solidification conditions. In the lower beads the large grains have been somewhat refined by the heat of the metal which was deposited above, but the upper beads show a very coarse, and consequently weak, structure. The zone of fusion is neither well marked nor uniform. This condition, doubtless, resulted from the uncertain nature of the arc.

The photomicrograph designated as "Section 1" gives a clear idea as to the effect of atmospheric gases which, in the case of bare rod welding, are not excluded. There is wide difference of opinion among metallurgists regarding the absolute nature of the needle-like structure which is present here. The opinion of the majority, however, seems to be this: The so-called "needles" are really transverse sections through very thin plates. The plates are composed of one or more of the following—iron oxide, iron—iron oxide eutectic, iron nitride, iron—iron nitride eutectic. The balance of the evidence appears to favor the belief that the plates are composed essentially of the nitride. The iron-nitrogen system is age-hardening.

Briefly stated and with purely theoretical considerations eliminated, atmospheric gases, if present in the arc, produce plates in the weld metal. These plates break up the continuity of the metal, thus lowering its strength and ductility. It is readily seen that in "Section 1" there is no true grain structure. The constituents are ferrite and the nitride "needles."

"Section 2," shows some semblance of a respectable grain structure, but the grains are irregular and are contaminated. The metal is obviously porous, and the effect of atmospheric gases is still quite evident. The refinement which produced the structure of "Section 2" results from the annealing action of hot metal above.

"Section 3" gives evidence of further refinement, but the grains are still distorted. Nitride does not give evidence of its presence, but analysis reveals that the constituent is in a condition of submicroscopic dispersion throughout those areas where the microscope does not show the needle-like arrangement.

"Section 4" shows a lack of clearly defined structure in the fusion zone and a presence of distorted, irregular grains. "Section 5" was included to provide a basis for comparison. In the parent metal we have the typical low carbon steel microstructure. Compare this regular arrangement with the distorted arrangements in the weld metal.

The fractured tensile test specimen clearly indicates the lack of ductility in a bare rod weld. It will be noted that the fracture shows no necking down and that there is no reduction or gradation in cross-sectional area.

Butt Weld Made With Shielded Arc Electrodes:

The central section of Plate 2 typifies the sort of weld metal generally deposited from a shielded arc welding electrode. There is a minimum of porosity, inclusions or the like. Interpenetration of beads is remarkably good, and it has been possible to deposit each bead in a remarkably uniform fashion. The fusion zone is well marked and is regular. Grains in the top beads are but faintly columnar and their size is about the same as the grains in the lower beads. In brief, the metal is homogeneous and uniform throughout.

"Section 1" shows a true grain structure and even in the locality, where there has been no subsequent refining by heat, the grains are much smaller than those of the parent metal. There are no nitrides appearing in the photomicrograph—no signs of contamination by impurities.

The remarks just made apply equally well to "Section 2" and to "Section 3", with the qualifications that there is a very small amount of progressive refinement toward the bottom of the Vee. However, the essential fact remains that the weld metal has fine, equi-axed grains homogeneously arranged

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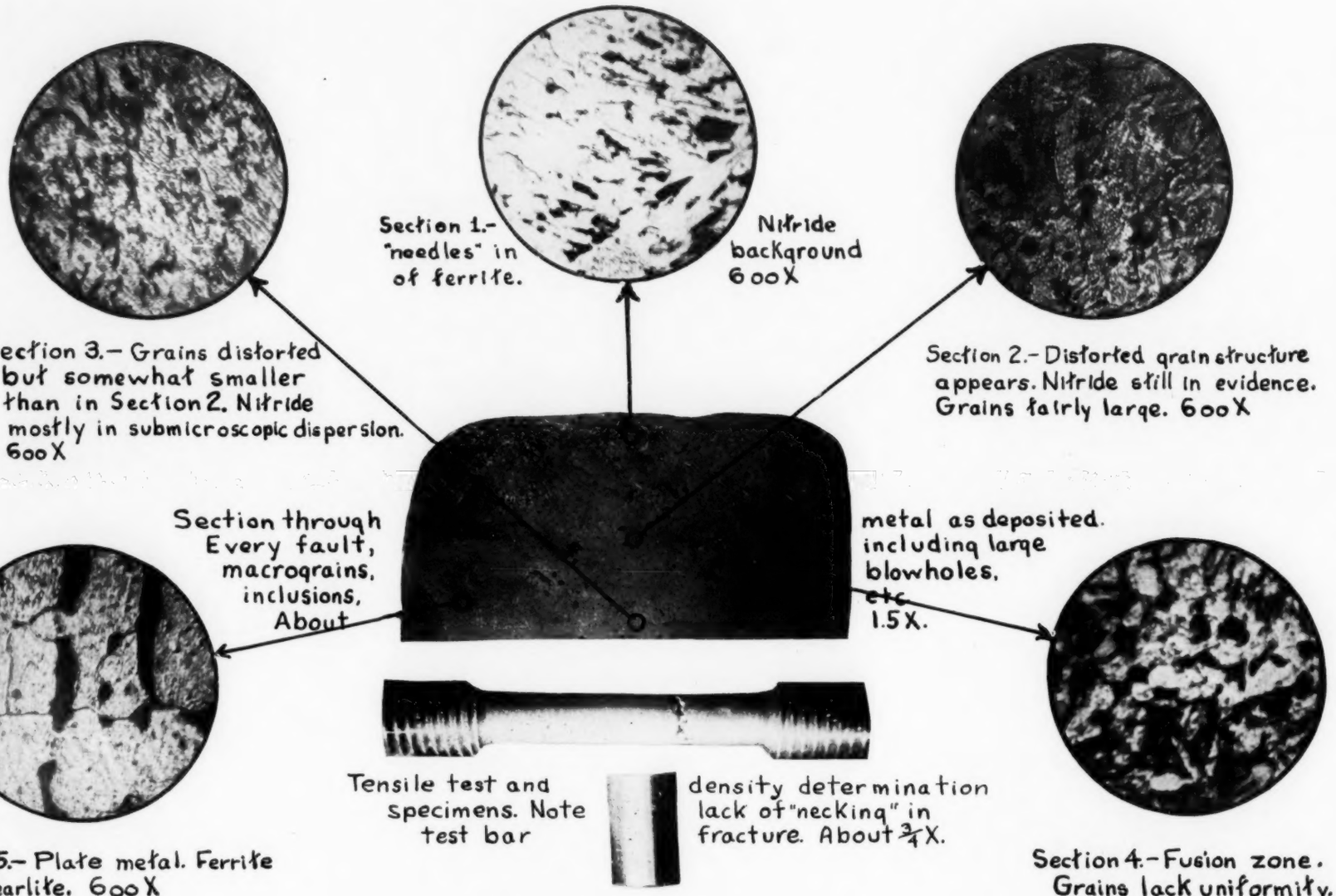
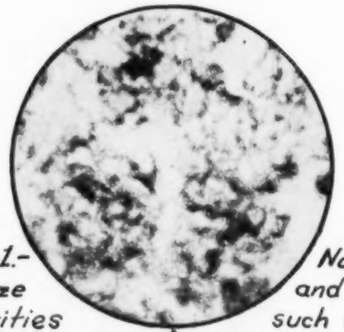

Section 1.- "needles" in of ferrite.
Nitride background 600X
Section 2.- Distorted grain structure appears. Nitride still in evidence. Grains fairly large. 600X
Section 3.- Grains distorted but somewhat smaller than in Section 2. Nitride mostly in submicroscopic dispersion. 600X
Section through Every fault, macrograins, inclusions, About
metal as deposited. including large blowholes, etc 1.5X.
Section 5.- Plate metal. Ferrite and pearlite. 600X
Tensile test and specimens. Note test bar
density determination lack of "necking" in fracture. About 3/4X.
Section 4.- Fusion zone. Grains lack uniformity. Poor continuity because of platy structure. 600X

Test data: All-weld-metal specimens.

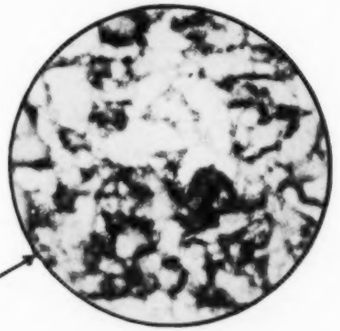
Specific Gravity	7.51
Yield Point	46300 lbs./sq. in.
Ultimate Strength	58000 " " "
% Elongation in 2"	6.0
% Reduction of Area	16.0
Brinell Hardness	179

PLATE I



Section 1.- grain size of impurities oxides, etc. 600 X.

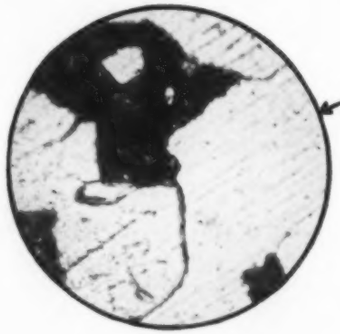
Note small and absence such as nitrides,



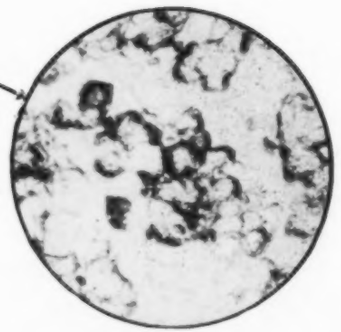
Section 2.- Evidence of refinement. Uniform, equi-axed grains, free from impurities. 600X.

Section 3- Structure comparable with sections 1+2. Grain structure is practically the same throughout

Section through metal as deposited. Note inter-penetration of beads and absence of inclusions and blowholes. 15X.



Tensile test and density determination specimens. Tensile test specimen fractured. Observe neck-ing at break. This denotes high ductility. Both specimens are shown at 1 X.



Section 4.- Structural gradation in zone of fusion. This photomicrograph suggests high strength in the joint. Good interlocking. 600 X.

Section 5.- Relatively large grains in hot-rolled parent metal. Comparison of this structure with that of sections 1, 2, + 3 partially explains why weld is stronger than the plate metal.

Test Data: All-weld-metal specimens.

Specific Gravity	7.83
Yield Point	60500 lbs./sq. in.
Ultimate Strength	71400 " " "
% Elongation in 2"	27.0
% Reduction of Area	40.5
Brinell Hardness	170

throughout every part of the deposition. Attention is especially directed to the structure in the zone of fusion. When it is recalled that small, well interlocked grains always produce high strength and good ductility, the significance of these photomicrographs is better appreciated.

The tensile test specimen pictured on Plate 2 shows what might be termed a ductile "fracture." The bar necked down to the point where it broke and after completion of the test the fracture was of the "cup and cone" order with very fine, even grain structure apparent. Definite information regarding the mechanical and physical properties may be found in the Table 2.

Stress-Strain Curves:

Some interesting comparisons are presented in Fig. 1 which shows stress-strain curves for (I) shielded arc electrode all weld metal, (II) bare welding rod all weld metal and (III) hot rolled low carbon steel. The curves show the relative mechanical properties of the three types of metal tested. It will be observed that the yield point of bare rod weld metal is some 10,000 lbs./sq. inch higher than the yield point of hot rolled steel. Rolled steel, on the other hand, after yielding will stand about three times as much elongation without fracture as will bare rod weld metal. The ultimate strength of the two are about the same. Shielded arc electrode weld metal is seen to have a yield point higher than either of the other two. Its ultimate strength is also superior, while its elongation compares very favorably with that of hot rolled steel.

Corrosion Resistance Properties:

Corrosion resistance properties of shielded arc electrode weld metal compared to bare rod weld metal and boiler plate steel, are shown in Plate No. 3. These test pieces were made by welding together boiler plates, using in one case a bare steel welding rod and in the other a shielded arc electrode. These test pieces were submerged in 50 per cent solution of hydrochloric acid. The bare rod weld was kept in the acid for six days only, while the shielded arc weld was subjected to the same acid attack for twenty days. Results indicate that, while the parent metal corroded in proportion to the time it was subjected to acid attack, and was deeply corroded in twenty days, the shielded arc weld, in the same length of time, showed very little corrosion effect. This clearly shows that shielded arc electrode weld metal has higher corrosion resistance than good grade boiler plate steel. This is because of the purity, density and uniformity of the deposited weld metal.

Welding Technique:

Every experienced welder knows that even with similar electrodes, variations in technique are necessary to obtain the best welding results. Therefore, it is only to be expected that the introduction and use of any of the newer types of rods, especially the shielded arc and alloy coating varieties, are going to demand special adaptations and changes in welding technique. Unfortunately there is still too little information in existence to permit anyone to state definitely just what technique will give the best results in each particular application. True, welding rod manufacturers know generally what procedure should be employed with each type of rod, but beyond this, co-operative experimentation by the welder, on each new application, is essential if the user of the rod is to enjoy the maximum benefits.

Up to this point we have concerned ourselves principally with basic developments and improvements in the process of welding. We have found that it has progressed from the point where weld metal was virtually all tensile strength and no ductility, to the point where a properly made weld may contain metal more ductile than the plates it joins and yet will maintain tensile strength exceeding that of the parent metal. We have found, too, that highly complex and specialized alloy steels can be successfully fabricated by arc welding. In short, we have shown that industry now has at its disposal a new and relatively perfected basic process for fabricating most types of steels.

TABLE 2

COMPARISON, SECTION BY SECTION, OF BARE ROD WELD WITH SHIELDED ARC ELECTRODE WELD

Section	Bare Rod	Shielded Arc Electrode
Central	Large blow holes, large and smaller grains. General lack of uniformity in weld metal. Impurities. All these factors cause low strength, poor ductility, low corrosion resistance, etc.	Dense metal, firmly fused to plates. Homogeneous and uniform. Free from impurities. Strong, ductile and highly resistant to corrosion.
1	Very large grains, Nitrides, which interfere with metallic continuity. No control of granular structure. Weak and highly corrodible.	Small, uniform grains. No contamination. Good granular structure, despite absence of subsequent annealing effect.
2 and 3	Grain is distorted. Consequent directional properties. Undesirable impurities. Gradation in grain size.	Grains equi-axed. Approximately equal properties in all directions. Pure steel. Grain size practically constant.
4	Poor interlocking. Weak joint. Impurities.	Good interlocking. Small grained, tough joint.
Tensile Specimen	Brittle. Low strength. Low ductility. Coarse grained fracture.	"Necking" at fracture. Fine grains. Strong and ductile.
Corrosion Resistance	Very low because of pores, non-homogeneous microstructure and impurities.	Higher than that of hot rolled steel, because of purity and uniformity throughout.

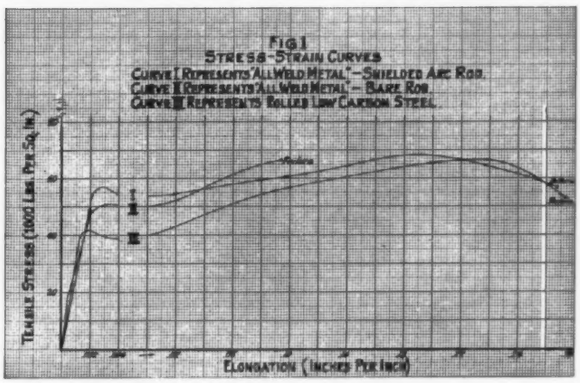


FIG 1
STRESS-STRAIN CURVES
CURVE I REPRESENTS "ALL WELD METAL"—SHIELDED ARC ROD.
CURVE II REPRESENTS "ALL WELD METAL"—BARE ROD
CURVE III REPRESENTS ROLLED LOW CARBON STEEL
TENSILE STRESS (1000 LBS. PER SQ. IN.)
ELONGATION (INCHES PER INCH)

FIG. 1

Applications of Electric Arc Welding:

The extent to which this process has been adopted can be shown by a brief survey and we find that today electric arc welding is employed for an almost limitless number of applications, from the manufacture of thin metals, such as are used in the automobile industry, to the largest fabricated structures where the metal may be of any practical thickness. Ships, locomotives, trucks, oil and gas pipe lines, buildings, bridges, aircraft structures, gas tanks and machinery of all kinds are today electric arc welded. The dependability of this new production tool is emphasized by the fact that for certain classes of vessels, especially those subjected to enormous pressures and for most severe and hazardous services, electric arc welding has almost entirely replaced riveting.

Welding In Steel Fabrication Field:

In the steel fabrication field, electric arc welding is an important tool of production, due to its flexibility, dependability and economic advantages. In many instances welding improves the product and at the same time lowers the cost of the unit. It also makes new products possible which could not otherwise be economically fabricated by any other process. Reductions in production costs are affected by elimination of patterns, by saving in time, by saving in the amount of material required and, quite often by saving in the cost of material.

Greater flexibility in design and in manufacturing operation, as well as a material reduction in stock requirements are possible with welding. Many items, which used to be made of castings, are today more economically fabricated from standard structural steel shapes properly welded. These economies are especially true in the manufacture of machine parts, involving only one or a few such units, in which case, the cost of patterns often times is a considerable part of the total cost of the casting.

Welded units, as compared with parts made from castings, are usually lighter in weight, yet may have greater strength and rigidity. Absence of porosity, shrinkage cracks and gas pockets found in castings are among the many advantages of welded units.

Even with all these advantages in favor of welded parts, castings have a definite place in our industries and it is questionable that the day will ever come when welded units will completely replace them. Cost per unit of finished product is the real answer to whether it should be made of castings or fabricated by welding.

Welding As a Maintenance Tool:

In the maintenance and repair fields arc welding is even more firmly established.

Reclamation of water cooled accessories, such as Blast Furnace tuyeres, Open Hearth and Heating Furnace doors and frames, Furnace Buckstays and Skewbacks, etc., is a routine job, keeping welders busy when not otherwise engaged.

The new hard surfacing welding rods are being widely used because they effect great economies by their use. Not only worn out parts are reclaimed, but also the useful life of such parts as dies, dipper teeth, coke pusher rams and miscellaneous parts of rolling mill equipment is lengthened many times.

Such parts as high manganese castings may today be successfully reclaimed by welding, without materially affecting the heat treatment of the parent metal.

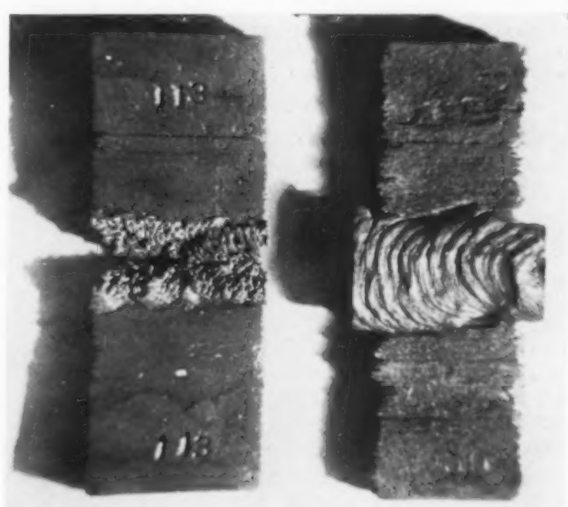


PLATE 3

Repair of broken castings, forgings, etc., by welding or replacement with parts fabricated from rolled sections by cutting and welding, offers one of the greatest opportunities for saving, not only by effecting quick and economical repairs, but by reducing parts inventories, due to the short time necessary, now, to provide replacements fabricated from the stock yard.

Pipe line repairs, changes and additions are now as a matter of course accomplished by welding. The preliminary preparation, in the case of minor jobs, often being done in the field, has become much simpler with welding fittings. In the old days of cast and machined fittings, even a simple repair or change was an expensive item, requiring careful preparation and considerable advance notice.

All these arc welding applications are existent and successful today and no one can say, with certainty, how much farther the trend toward this type

of fabrication will go. However, there are at least two factors which indicate that the movement has only begun.

First, the proportional demand for specialized electrodes, particularly shielded arc types, is increasing tremendously from year to year. The curve is definitely and sharply upward; there has been no leveling off, no indication that a comparative saturation point in natural demand is being approached.

And, second, the economic situation now confronting the industries gives every appearance of being one of constant and increasingly severe competition. Uneconomic units in our industrial system are inevitably on their way out and the cutting of ultimate costs is the only means by which many units can hope to survive. For these reasons and because of its proved economies and already wide field of application, welding deserves proper consideration and its increased use will follow.

The author's thanks are due to Messrs. J. B. Austin and G. E. Durham, metallurgists for Una Welding, Inc., for their generous assistance in the preparation of the tables, plates and other detail technical data.

GLOSSARY

Ferrite—Practically pure iron as seen under the miscroscope.

Grain—All metals are crystalline. A grain is a more or less homogeneous or regular aggregate of very small metallic crystals.

Impurity—An impurity, metallurgically speaking, is some substance other than the essential element of the alloy and present in such a quantity as to exert a harmful effect. If the substance exerts a favorable effect it is not considered as an impurity, but rather as an alloying element, e.g. carbon in steel.

Inclusion—Any substance which is present in a metal or alloy and which is retained purely because of the fact that it was imbedded in the metal or alloy at the time of solidification.

Macrograin—A metallic grain so large as to be seen by the naked eye or at a magnification of less than ten diameters.

Macroscopic—Of or pertaining to magnifications of the order of ten diameters or less.

Metallography—The science which applies to the internal structure and form of metals in relation to the external processes and stresses applied to those metals.

Microscopic—Of or pertaining to the miscroscope; of, or pertaining to, magnifications greater than ten diameters.

"Necking" or "Necking Down"—The manner in which a ductile test bar, being stressed in tension, is reduced in cross-sectional area at one particular point to such an extent that the stress per unit area is concentrated and produces fracture. If the test bar is not ductile, there will be no reduction at any special point and the point of fracture cannot be predicted in such a case.

Pearlite—A constituent in slowly-cooled steel. It consists of alternate plates of ferrite and cementite (iron carbide). It appears entirely dark at less than 500 diameters magnification when etched in nitric acid.

Photomacrograph—A photograph of an object or a structure magnified less than ten diameters.

Photomicrograph—A photograph of an object or a structure magnified more than ten diameters.

Refinement—The production of a more uniform, stable, or homogeneous structure; also, reduction in grain size.

Sorbite—A constituent in steel cooled so rapidly as to prevent the formation of pearlite. Sorbite is dark after a nitric acid etch. Above 600 diameters magnification this constituent appears as very small, well defined spheroidal particles.

Sorbito-Pearlite—Pearlite which forms too rapidly to permit the production of a truly lamellar structure.

Structure—Of a metal refers to the general arrangement of crystals and grains in that metal as well as to the nature of the grains and the type of constituents represented. Structure also implies the arrangement and nature of atoms within a single crystalline unit. **Microstructure** refers to structures as revealed at the various powers of the microscope.

Zone of Fusion—That part of the weld in which deposited metal and base metal fuse together.

Heat Transfer To The Open Hearth Bath

By WILLIAM C. BUELL, JR.
Engineer, Cleveland, Ohio.

Abstract of paper to be presented at the A. I. & S. E. E. Annual Convention in Pittsburgh, October 17 to 19, 1933.

With 45% hot metal and low carbon basic practice about 800,000 B.t.u. of heat must be added to the bath for each ton of steel produced.

As more than five and often six or seven times the amount of this heat must be supplied as primary fuel in order to accomplish this result, any factors which might tend to increase the rate of heat transfer to the bath are worthy of the closest investigation.

The most useful index of the comparative production rates of open hearth furnaces is found in the term "square feet of hearth necessary to produce one ton of steel in one hour."

This value is developed from the operating records of fifteen modern furnaces, seven fired with raw fuels and eight with fixed fuels.

From operating and engineering data the furnace gas velocity ranging from 4.7 to 11.9 feet per second and the time of gas contact with the bath ranging from 3.1 to 7.8 seconds is found and the transfer coefficient ranging from 18 to 33 B.t.u. per square

WILLIAM C. BUELL, JR.

foot per hour per degree temperature difference in the several furnaces is developed.

These results are plotted and trend lines established that indicate a longer time of gas contact will produce material fuel economy.

Inasmuch as a longer time of contact means a diminished gas velocity it is shown that if the factor of time is correctly included in the problem, a much greater relative heat transfer will actually result from the lower velocity, instead of a lesser heat transfer, as might be assumed were the rule that increasing the velocity increases the heat transfer rate applied without proper qualification.

To maintain present production rates with a lower gas velocity indicates that the chamber over the bath must be materially enlarged which makes it mandatory that the roof be raised.

While it may be difficult to accomplish this in existing plants, it will be well worthwhile for, in addition to fuel economy, roof life will be materially lengthened, and charging, particularly of light scrap, expedited.

Reduction Gear Sets In Connection With Main Drive Mill Motors

By T. HOLLOWAY
Gear Consultant, United Engineering & Foundry Company, Pittsburgh, Pa.

Abstract of paper to be presented at the A. I. & S. E. E. Annual Convention in Pittsburgh, October 17 to 19, 1933.

Tooth Engagement of Spur, Helical Spur and Herringbone Gears

It is difficult to generalize upon the merits of different types of involute tooth form design for parallel axes. There are, however, definite characteristics of each type which irrespective of proportion remain constant.

Straight Tooth Spur Gears:

When a load is applied to a straight tooth gear it is effective on a line parallel to its axis, but during various phases of tooth engagement there is an uneven number of teeth which share the load; consequently, at different parts of the tooth contour the load is unequal and this results after a period of years in uneven wear and a consequent interruption in the transmission of uniform angular velocity. In other words, the true theoretical contour of the tooth is mutilated during service and there is consequently noise and vibration present. Lantern slides illustrate this point. One illustration shows a pair of spur gears marked with a line of action along which the pressure is applied when only one tooth is in contact. The second illustration shows the same spur gear with two teeth in contact. It will be obvious that the load of a spur gear is greater at the center of the tooth than it is at the tips and roots. This condition can vary in intensity according to proportions but it remains an inherent characteristic of the spur gear.

T. HOLLOWAY

Helical Spur Gears:

Helical spur gears really consist of an infinite

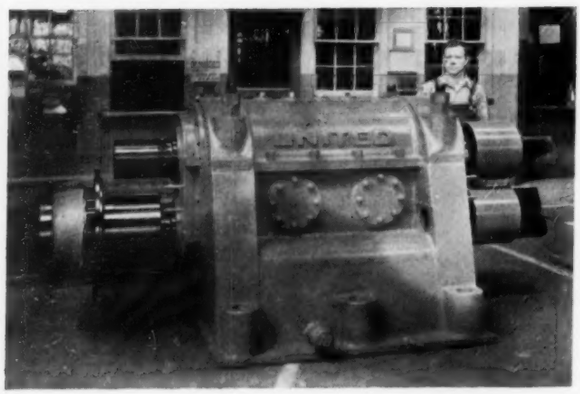


FIG. 1

number of spur gears arranged so that the teeth trace a helix. The line along which the load is applied, which will be seen from the illustration, is oblique to the axis and stretches across the face from the roots to the tips of the teeth. The load is, therefore, uniform from root to tip and this type of gear has a tendency, when it wears, to wear evenly over the entire height of tooth and to operate smoothly even after long service. The multiplicity of teeth in contact at one time eliminates impact loads and renders the motion smooth. There is the disadvantage, however, that to obtain really smooth action, the helix angle must be relatively high and this causes an axial thrust which is often inconvenient.

Herringbone Gears:

Almost immediately after the discovery of the single helical gear, the advantages obtainable with the use of two single helical gears of opposing hands of helix were apparent and long before machinery was devised for cutting herringbone gears, cast gears with double helical teeth and high helix angle were in common use. The angle of helix most desirable is the angle which enables the largest number of teeth to be simultaneously in contact but with the normal thickness of the teeth becoming thick enough to properly support the load. The angle of 23° at one time most generally used, was merely selected for manufacturing reasons, the design of the hobs being most convenient for this angle.

Another section of this paper deals with the use of welded steel construction of large mill drives and pinion stands. Several interesting examples are shown in detail, a typical illustration being the 20" pinion stand shown in the illustration, Fig. 1.

STATEMENT OF OWNERSHIP, MANAGEMENT, ETC., OF

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JOHN F. KELLY, Editor.

Sworn to and subscribed before me this 26th day of September, 1933.
HENRY W. BALDWIN, Notary Public.
(My commission expires April 16, 1937).

C. J. KLEIN,
Author

J. W. BATES,
Secretary Technical Section
Tuesday, October 17, 1933

C. A. KRAL,
Chairman Technical Session
Tuesday, October 17, 1933

Tabulation of Applications of Anti-Friction Bearings to Roll Necks of Steel Rolling Mills

The Association of Iron and Steel Electrical Engineers presents herewith a tabulated list of Anti-Friction Bearings applied to roll necks in the Iron and Steel Industry.

This list is submitted to the Iron and Steel Industry with the purpose of indicating only the progress being made in the application of Anti-Friction Bearings to roll necks.

The engineering data and information furnished in this list, has been secured from so many sources that it may require corrections and additions from time to time. The list does not represent the complete installations in the Industry however over 90% of the steel mill ingot tonnage capacity is accounted for.

The Association will welcome constructive suggestions on additions and corrections.

Mill.	Type.	No. of Stands.	Roll Data. Work Roll	Roll Data. Backg Roll	Roll Data. Body Lgths.	Where Operating.	Position of Bearing.	Bearing Number.	Make of Bearing.	Year In'st'ld
Hot Sheet, Strip & Plate Mills.										
Hot Strip	4-High	4	18"	37"	38"	Allegheny Steel Co. Brackenridge, Pa.	Backing Rolls Work Rolls	525185 - 525321. 275106 - 275160 - 61.	Timken.	1932.
Hot Strip.	4-High	3	16"	38"	48"	American Rolling Mill Co. Butler, Pa.	Backing Rolls	480181 - 480340.	Timken	1929 1932-33
Hot Strip.	4-High	4	18"	40"	58"	American Rolling Mill Co, Middletown, Ohio.	Backing Rolls 1 Work Roll Thrust End	327221 - 327355 - 56 275106 - 275160 - 61	Timken	1929 1931.
Hot Strip	4-High		16"	38"	48"	American Rolling Mill Co. Butler, Pa.	Backing Roll		Bantam	
Hot Strip.	4-High	4	16"	34"	41"	American Sheet & Tin Plate Co., Gary, Ind.	Backing Rolls Work Rolls:- Drive End Opp. End 1 Backing Roll	425178-19-425298-99 89108 - 89150 - 51 EE 126096 - 126150 13" × 30" × 20¾"	Timken Timken Bantam	1930. 1932-33 1933.
Hot Strip.	4 High	6	18"	37"	38"	Great Lakes Steel Corporation. Ecorse, Mich.	Backing Rolls Work Rolls	525182 - 525320 275106 - 275160 - 61.	Timken	1930.
Continuous Plate Mill	4-High	6	24"	52"	96"	Illinois Steel Co., So. Chicago, Ill.	Backing Rolls Vertical Edger	690296 - 690465 - 66	Timken Bantam	1931. 1931.
Hot Strip.	4-High	1 9	36" 25"	49" 49"	96" 76"	Inland Steel Co., Indiana Harbor, Ind.	Backing Rolls. Backing Rolls Work Rolls	628285 - 628465 627260 - 627435 234157 - 234215 - 16	Timken	1932.
Hot Strip.	4-High	2	11"	22"	20"	Laclede Steel Co., Alton, Ill.	Backing Rolls Backing Rolls	551000 - 551700 - 01 C3 - 31077 C3 - 31031	Timken Rollway	1927. 1928
Continuous Skelp Mill	4-High		13"	26"	20"	National Tube Co, McKeesport, Pa.	Backing Rolls	1 - 26315	S.K.F.	
Hot Strip.	4-High	5	20"	45"	72"	Otis Steel Co, Cleveland, Ohio.	Backing Rolls Work Rolls Thrust end.	527236 - 37 - 527380 - 81 129121 - 129172 - 73	Timken	1932.
Hot Strip.	4-High		16"	32"	42"	Republic Steel Corp. Warren, Ohio.	Backing Rolls Work Rolls.		Bantam	
Hot Strip.	3-High	1	12"	7" Baby Roll	14"	Stanley Works. Bridgeport, Conn.	Baby Roll	74539 - 74850	Timken	1932.

Hot Sheet, Strip & Plate Mills, Continued.

Mill	Type	No of Stands	Roll Data: Work Roll	Roll Data: Back'g Roll	Roll Data: Body Lgths	Where Operating	Position of Bearing	Bearing Number	Make of Bearing	Year In'st'd
Hot Strip	4-High	4	15"	32"	24"	Sharon Steel Hoop Co Sharon, Pa	Backing Rolls Work Rolls	726181-726287 9975-9920	Timken	1932
Hot Strip	4-High 4-High	3 6	21" 18"	44" 44"	60" 60"	Wheeling Steel Corporation, Steubenville, Ohio	Backing Rolls Work Rolls Backing Rolls Work Rolls	662301-663550-51 231401-232025 662301-663550-51 111201-111700	Timken	1928
Hot Strip	2-High	2	10½"	-	18"	Washburn Wire Co. Phillipsdale, R.I.	Caster Rolls on W.R. Necks	840762-842200	Timken	1929
Hot Sheet	3-High	1	20"	32"	48"	Youngstown Sheet & Tube Co, Youngstown, Ohio	Middle Roll	EE 291203-291750	Timken	1933

Cold Sheet, Strip & Tin Plate Mills.

Cold Strip	4-High	1	5½"	19"	18"	Acme Steel Company Riverdale, Ill	Backing Rolls Work Rolls	551090-551700-01.	Timken Rollway	1930 1928
Cold Strip	4-High	4	12"	30"	50"	Allegheny Steel Co, Brackenridge, Pa	Backing Rolls	571700-572650-51	Timken	1927
Cold Strip	4-High	1	14"	34"	58"	American Rolling Mill Co, Ashland, Ky	Top Backing Roll Bottom Backing Roll	671799-672873-74 425178-79-425298-99	Timken Timken	1929 1931-33
Cold Strip	4-High	1 6	14" 14" 14" 14"	30" 30" 30" 30"	42" 42" 42 42"	Butler, Pa.	Backing Rolls Backing Rolls Backing Rolls Work Rolls	EE 924172-924289 571700-572650-51 CS-31064	Timken Timken Bantam Rollway	1933 1926 1933 1928
Cold Strip	4-High	1	16½"	40"	48"	Middletown, Ohio	Backing Rolls Work Rolls		Bantam	1933
Cold Sheet	2-High	1	26"	-	58"	Butler, Pa.	Roll Necks	911601-912400-01	Timken	1929-31
Cold Strip	4-High	1	16"	46"	42"	American Sheet & Tin Plate Co, Gary, Ind.	Backing Rolls Work Rolls 2 per position	629256-629405-06 93801-93125	Timken	1931
Planishing Stand	4-High	1	13"	27"	42"	" "	Backing Rolls Work Rolls	EE 321146-321245 94704-94113	Timken	1933
Cold Mill	4-High	1	20½"	56"	84"	" "	Backing Rolls Work Rolls	EE 727302-727511 EE 129121-129172-73	Timken	1933
Cold Mill	4-High	1	20½"	56"	84"	" "	Backing Rolls Work Rolls	30" × 51" × 25½" 12" × 17½" × 11"	Bantam	1933
Reversing Cold Tin Plate	4-High	1	16"	49"	42"	" "	Backing Rolls Work Rolls Backing Roll	EE 428262-428420-21 93801-93125 2 per position 26" × 42" × 25½"	Timken Timken Bantam	1933 " "
Cold Mill	2-High	1	24"	-	44"	" "	Roll Necks		Bantam	1933
Cold Sheet	4-High	1	16"	48"	84"	Farrell, Pa.	Backing Rolls	532296-532445-46	Timken	1930
Cold Sheet	4-High	1	16"	34"	55"	McKeesport, Pa.	Backing Rolls Work Rolls.	CS-31042 CS-31041	Rollway	1928

Cold Sheet, Strip & Tin Plate Mills, Continued

Mill	Type	No of Stands	Roll Data: Work Roll	Roll Data: Backg Roll	Roll Data: Body Lgths	Where Operating	Position of Bearing	Bearing Number	Make of Bearing	Year Instld
Cold Strip	2-High	1	18"		32"	American Steel & Wire Co, Cleveland, Ohio.	Roll Necks	251000-251515 2 per position	Timken	1927
Cold Strip	Cluster Tandem	4	10½"	21½"	32		Backing Rolls	941200-941950-51	Timken	1927
Cold Strip	4 High Tandem	4	14"	25"	16"		Backing Rolls Work Rolls 2 per position	790117-790220 82576-82950	Timken	1931
Cold Strip	4-High Tandem	4	16½"	33"	26"		Backing Rolls Work Rolls 2 per position	123167-123290 94700-94113	Timken	1931
Cold Mill	2-High		8⅜"	-	8"		Roll Necks	I 70176 6221	S.K.F.	
Cold Mill	2-High		10⅝"	-	10¼"		Roll Necks	I 70177 6228x	S.K.F.	
Cold Mill	2-High		10⅝"	-	18"		Roll Necks	I 70177 6228x	S.K.F.	
Cold Mill	2-High		10⅝"	-	18½"		Roll Necks	7813 6228x376	S.K.F.	
Cold Mill	2-High		13"	-	24"		Roll Necks	I 70192 6234x	S.K.F.	
Cold Mill	2-High		16½"	-	24"		Roll Necks	I 70191 I 70193	S.K.F.	
Cold Strip	2-High		8"	-	8"		Roll Necks		Bantam	
Cold Strip	2-High		10"	-	18"		Roll Necks		Bantam	
Cold Strip	2-High		16"	-	24		Roll Necks		Bantam	
Cold Mill	2-High	19	8"	-	8"	Worcester, Mass.	Roll Necks	71450-71750	Timken	1933
Cold Mill	Special		14½"	-	10"	Athenia Steel Co. Clifton, N.J.	Roll Necks	22332	S.K.F.	
Cold Mill	Special		6¾"	-	44¼"		Roll Necks	22315		
Cold Strip	Cluster	1	7"	14"	24"	E.W. Bliss Co. Salem, Ohio.	Backing Rolls	210750-211300-01	Timken	1929
Cold Strip	3-High	1	2¾"	8½"	10"	Driver-Harris Co. Harrison, N.J.	Roll Necks	938-932	Timken	1933
Cold Mill	4-High	1	12"	28"	30"	Greer Steel Co, Dover, Ohio	Backing Rolls Work Rolls	EE 321146-321245 82576-82950	Timken	1933
Cold Mill	2-High	2	27"	-	48"	Inland Steel Co. Indiana Harbor Ind.	Roll Necks	321146-321245	Timken	1932
Cold Planishing	4-High	2	18"	39"	42"		Backing Rolls	EE 525185-525321		1933
Cold Mill	Cluster	2	14"	24"	42"	International Nickel Co, Huntington, W.Va.	Backing Rolls	971352-972100-02	Timken	1930-31
Reversing Cold Tin Plate	4-High	1	16½"	53"	42"	Jones & Laughlin Steel Corporation, Aliquippa, Pa	Backing Rolls Work Rolls	EE 528301-528480-81 EE 93801-93125	Timken	1933
Cold Strip	4-High	2	20½"	52"	72"	Otis Steel Company Cleveland, Ohio.	Backing Rolls Work Rolls Thrust End	532297-532445-46 129121-129172-73	Timken	1932
Cold Strip	Cluster	1	14"	27"	54"	Republic Steel Corporation Canton, Ohio.	Backing Rolls	261600-262500-01	Timken	1927
Cold Strip	4-High	1		6"	16"		Work Rolls	C5-31099	Holloway	1929
Cold Strip Stainless	4-High	2	15"	32"	20"		Backing Rolls Work Rolls		Bantam	
Cold Strip	4-High	1	9½"	24"	20"		Backing Rolls	941200-941950-51	Timken	1928
Cold Strip	4-High		16"	32"	20"	Warren, Ohio	Backing Rolls Work Rolls		Bantam	

Cold Sheet, Strip & Tin Plate Mills, Continued.

Mill	Type	No. of Stands	Roll Data. Work Rolls	Roll Data. Backg Rolls	Roll Data. Body Lgths	Where Operating.	Position of Bearing.	Bearing Number.	Make of Bearing	Year Instld
Cold Mill.	Tandem Cluster.	4	10½"	21"	26"	Sharon Steel Hoop Co, Sharon, Pa.	Backing Rolls	941200-941950-51	Timken	1928.
Cold Mill	Cluster.	1	8½"	16½"	26"		Backing Rolls	221025-221575-76	Timken	1928.
Cold Mill	Tandem Cluster.	3	8½"	16½"	18½"		Backing Rolls	221025-221575-76	Timken	1928.
Cold Finishing	2-High.	1	18"	-	26"		Roll Necks	221025-221575-76	Timken	1928.
Narrow Strip	2-High		8½"				Work Rolls	CS-21063	Rollway	1928.
Narrow Strip	2-High		10½"	-	10"		Work Rolls	CS-31046.	Rollway	1928.
Cold Strip	2-High		10½"	-	18"		Work Rolls	CS-31046.	Rollway	1928.
Cold Mill.	2-High	1	14"	-	14"	Stanley Works New Britian, Conn.	Roll Necks	280700-281200-01.	Timken	1930.
Cold Strip	4-High	1	7"	19"	24"	Thomas Steel Company, Warren, Ohio.	Work Rolls	CS-31064.	Rollway	1928.
Cold Strip	4-High	1	7"	19"	24"		Backing Rolls	551000-551700-01	Timken	1930.
Cold Mill.	2-High.	1	16"	-	24"		Roll Necks.	420800-421450-51	Timken	1930.
Cold Mill	2-High.	1	10"	-	16"		Roll Necks	95499-95925	Timken	1930.
Cold Strip.	4-High	1	4½"	16"	12"		Backing Rolls	780702-781400	Timken.	1929.
Cold Strip.	4-High	2	4½"	16"	12"		Backing Rolls. Work Rolls. 2 per position	780702-781400 3780-3720.	Timken	1931-32
Cold Mill	2-High	1	14"	-	14"	Wallingford Steel Company, Wallingford, Conn.	Roll Necks.	EE210752-211300-01	Timken	1932.
Cold Strip	4-High	1	7"	25"	16"		Work Rolls. Thrust Ends.	6461-6420. 2 per position	Timken	1932.
Cold Mill	3-High	1	7"	14"	14"		Middle Roll	579D-572	Timken	1933.
Cold Mill	4-High	1	2"	11"	4"	Westinghouse Electric & Manufacturing Co. Pittsburgh, Pa.	Backing Rolls	865-854	Timken	1930
Cold Mill.	2-High	2	27"	-	48"	Wheeling Steel Corp. Steubenville, Ohio.	Roll Necks.	321146-321245	Timken	1930
Cold Strip	4-High	4	18"	30"	32"	Yorkville, Ohio.	Backing Rolls Work Rolls	328172-328269 420804-421450	Timken	1930.
Cold Mill.	2-High.	1	27"	-	48"		Roll Necks.	321146-321245	Timken	1931.

Rod, Rail, Structural & Merchant Mills.

Rod Mill Nut Stock.	2-High.		8"			American Steel & Wire Co, Cleveland, Ohio.	Roll Necks	CS-31036	Rollway	1928.
Rod Mill Nut Stock	2-High		10"				Roll Necks	CS-31034	Rollway	1928
Beam Mill	Side Roll	1				Bethlehem Steel Co. Bethlehem, Pa.	Vertical Flange Rolls.	515060-515237	Timken	1930
Rail and Structural Mill	Side Roll	1				Bethlehem Steel Co. Steelton, Pa.	Side Rolls 2 per position	EE117063-117148	Timken	1928.
Rod Mill	2-High	1				Canadian Tube & Steel Products, Ltd. Montreal	Roll Necks.	73550-73875-86	Timken	1931.
Rod Mill.	2-High		9¾"	-	10"		Roll Necks	I-28805 I-37603 I-34105-K	S.K.F.	
Beam Mill	Universal	3				Carnegie Steel Co, Munhall, Pa.	Vertical Rolls.	141250-142550-51	Timken	1927.

Rod, Rail, Structural & Merchant Mills, Continued

Mill.	Type.	No. of Stands	Roll Data: Work Rolls	Roll Data: Backg Rolls	Roll Data: Body Lgth's	Where Operating.	Position of Bearing	Bearing Number.	Make of Bearing.	Year Inst'ld.
Bar Mill.	2-High	4	21"			Great Lakes Steel Corporation. Ecorse, Mich.	Roll Necks.	722111-722185-85.	Timken	1931.
Bar Mill.	2-High	6	18"				Roll Necks	551027-551662-63.		
Bar Mill. 2 Rolls per Stand.	3-High	2	18"				Roll Necks	551027-551662-63.		
Beam Mill	Universal	3				Illinois Steel Company, South Chicago, Ill.	Vertical Rolls.	141250-142651-52	Timken	1931.
Structural Mill. Feed & Back Stands	2-High	2				Kalman Steel Co, Buffalo, N.Y.	Roll Necks Left.	74537-74850	Timken	1928.
							Roll Necks Right.	71450-71750		
Structural Mill. Main Slitting Stand.	2-High	1					Roll Necks Upper & Lower Left	420800-421950		
							do. Upper Right	93800-93125 2 per position.		
							do. Lower Right	99550-99100. 2 per position		
Cotter Pin Mill	2-High	1				Page Steel & Wire Co, Monessen, Pa.	Roll Necks.	687-682	Timken	1933.
Billet Mills	3-High	2	28"			Timken Steel & Tube Company. Canton, Ohio.	Roll Necks.	911601-912400-01.	Timken	1929.
Billet Mills	3-High	2	22"				Roll Necks.	291200-291750-51.		
Merchant Mills	2-High	3	18"	-	36"		Roll Necks Drive Side	221025-221575-76.		
							do Opposite Side	220975-221025-221575-221576.		
Merchant Mills	2-High	6	16"	-	36"		Roll Necks Drive Side.	130900-131400-01.		
							do. Opposite Side	130850-130900-131400-131401.		
Merchant Mill	3-High	1	16"	-	36"		Roll Necks Drive Side	130900-131400-01.		
							do. Opposite Side.	130850-130900-131400-131401.		
Vertical Mill	2-High Vertical	1	12"				Roll Necks.	73550-73875-76.		

Tube Piercing, Reeling & Electrical Welding Mills.

#3 Disc Type Piercing Mill.		1				Babcock & Wilcox Tube Company, Beaver Falls, Pa.	Main Rolls. Piercing End	181452-182350-51.	Timken	1931
							Main Rolls. Opposite End	390095-390200		
Sizing Mills.		5					Roll Necks.	130900-131400		
Tube Elongator		1	21"	-	36"		Cross Roll Necks.	130900-131400		
Reeler		2					Roll Necks.	550998-551700-01		
Reducing Mill	Special						Roll Shaft	I-70302	S.K.F.	
Lap Weld Tube Mill.		1	6"	-	16"	Bethlehem Steel Co, Sparrows Point, Md.	Cross Roll Necks	99587-99100. 4 per position.	Timken	1927.
							Lower Cross Roll Necks	710900-711600 2 per position		
							Upper Cross Roll Necks	710900-711600 2 per position		

Tube Piercing, Reeling & Electrical Welding Mills, Continued

Mill	Type	No. of Stands	Roll Data. Work Rolls	Roll Data. Backg Rolls	Roll Data. Body Lgths.	Where Operating	Position of Bearing	Bearing Number.	Make of Bearing	Year Instl'd.
Tube Welding Machine		3				Fretz Moon Tube Company, Butler, Pa.	Roll Shafts.	74500 - 74850 2 per position.	Timken	1927
							Inner Vert. Roll Shaft Top & Bot.	861-854. 1 per position.		
							Outer Vert. Roll Shaft. Top.	861-854. 1 per position.		
4" Tube Butt Welding Machine		3					Vertical Roll.	558-552A Upper 2 Brgs.	Timken	1932
							Vertical Roll.	3982-3920 Lower 2 Brgs.		
							Hor. Roll. L.H.	558-552A 2 Brgs.		
							Hor. Roll. R.H.	3982-3920 2 Brgs.		
Piercing Mill.			27"			Globe Steel Tube Company, Milwaukee, Wis.	Journal.	22344 X	S.K.F.	
Reeling Mill.			28"				Journal.	22338		
Reeling Mill.			24"				Journal.	22336		
Gauging Mill.			12"		6"		Journal.	J-26303.		
Push Bench Sizing Mill.	Vertical Rolls	2				Jones & Laughlin Steel Corporation, Aliquippa, Pa.	Roll Necks 2 per position	99587-99100.	Timken	1931.
Tube Sizing Mill.		19 Rolls					Roll Necks.	462-452D.	Timken	1933.
Reducing Mill.	Special						Roll Shaft.	WUL-60 32211.	S.K.F.	
Butt Weld Sizing Mill	2-High	1				Laclede Tube Company, Alton, Illinois.	Overhung Sizing Roll	861-854	Timken	1930.
Reeling Mill			36"			National Tube Co., Gary, Ind.	Journal.	22352x	S.K.F.	
#4 Lap Weld Tube Mill		1					Roll Necks.	280700-281200-01	Timken	1928.
Tube Piercing Mill			24"			National Tube Co., Lorain, Ohio.	Main Rolls	8"x16"x10"	Bantam	1933
Hot Elongator			24"				Guide Discs	5"x10½"x3¼" 2 per position		
Piercing Mill.		1	34"			Timken Steel & Tube Company, Canton, Ohio.	Driven End	941202-941950.	Timken	1929.
							Opp. End	941102-941950.		
Return Mill		1	26"				Roll Necks	231401-232025-26.		1929.
Reelers.		2	26"				Roll Necks	280701-281200-01.		1929.
Reducing Mills.		33	12"				Roll Necks. 2 per position	99587-99100.		1927.
Piercing Mill		1	36"				Driven End	941202-941950.		1929
							Opp. End	941202-941950.		
Return Mill.		1	26"				Roll Necks.	231401-232025-26.		1929.
Reelers.		2	30"				Roll Necks.	550998-551700-01.		1929
Reducing Mills.		42	16"				Roll Necks.	280700-281200.		1929.
Butt Weld Tube Sizing Mill.	2-High.	1				Wheatland Tube Co., Sharon, Pa.	R & L Hand.	94650-94113. 95500-95925.	Timken	1931.
Butt Weld Tube Sizing Mill.	2-High	2				Youngstown Sheet & Tube Company, Indiana Harbor, Ind.	Right Hand. Left Hand.	94650-94113. 95500-95925 2 Brgs each position	Timken	1929.
Electric Weld. Tube Forming Mill.	2-High	15	24"			Youngstown Sheet & Tube Company, Youngstown, Ohio.	Roll Necks. 2 per position	291201-291750.	Timken	1930.
							Vertical Sizing Roll. Top.	99587-99100.		
							Vertical Sizing Roll. Bottom.	99600-99100.		
							Horizontal Sizing Rolls.	181451-182350		
							Small Sizing Rolls.	462-453A		
Electric Weld Tube Straightening Machine		1	24"				Straightening Rolls.	430900-431575 2 Brgs.		

Fifteen Years of Employee Representation*

By E. G. GRACE,
President, Bethlehem Steel Corp.,
Bethlehem, Pa.

This issue of Bethlehem Review marks the fifteenth anniversary of our Employees' Representation Plan. Our Plan was among the first of its kind to be introduced in American industry. It was a pioneer step in labor relations. Now, fifteen years later, the National Industrial Recovery Act recognizes the value of such a plan under its provision for collective bargaining. This means of collective bargaining has stood the test of time. It has served both employees and management in prosperous days and in hard times, and meets the requirements of the new law.

At its inception I stated that our Plan would be made an integral part of our business. That this has been done is evidenced by the important place it has come to occupy in our current affairs. The Plan has become vital in the administration of our business, affording as it does a method for the establishment of fair and proper schedules of wages, hours and other working conditions, and for guiding the various economic betterment plans which have been organized among and for the benefit of the employees over the last fifteen years.

No outside agency could possibly take the place of our Employees' Representation Plan, without destroying that all-essential direct contact and relationship so necessary to insure to employees the best possible working and living conditions, and to management the co-operation of an intelligently informed body of employees. Under the Plan the employees have been kept constantly advised, through their elected representatives, of the conditions of our business; and the part they have played in counselling and originating constructive labor policies is an attainment of which every employee can well be proud.

The principles of our Plan have been adopted by all other important steel companies, and by many large organizations in other industries. Meeting the requirements of the NIRA our Employees' Representation Plan continues to serve as the medium of representation just as it has in the past. I urge all employees to continue to use to the full the facilities of the Plan for presenting their needs and views. That is its purpose. No question can be raised by an employee that can react in any way against him.

The elected representatives under the Employees' Representation Plan have performed their duties in a fearless, intelligent and constructive manner. Nondiscrimination is the very fundamental of the Plan. A rigid adherence to this policy has been a powerful factor in making the Plan a continuing success, and no interference with this policy will be tolerated.

In view of misleading statements on the much discussed subject of the open and closed shop, of union and non-union labor, and in fairness to our employees, I feel it my duty to say plainly that no Bethlehem employee is required to belong to a labor union to get the full advantages of collective bargaining under the National Industrial Recovery Act. The Act provides for collective bargaining quite independent of an employee's affiliation or non-affiliation with any organization, union or otherwise. All of these benefits of collective bargaining are afforded under our Employees' Representation Plan without cost to the employee.

Bethlehem has whole-heartedly joined with the other companies in the steel business to have our great basic industry co-operate with the President of the United States and his Administration in overcoming the causes of the present depression. To this end we and all other important steel companies have subscribed to a Code of Fair Competition for the conduct of the industry during the emergency. Mutual understanding and united effort on the part of all are necessary to accomplish this great purpose. The Code aims to reach this objective for the industry as a whole; and within our company an effective agency for accomplishing this co-operation is the Employees' Representation Plan. Let us, therefore, continue to so operate the Plan that we may, as employees and citizens, make our full contribution toward national recovery.

* Reprinted from the September issue of the Bethlehem Review.

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W. R. CULBERTSON, Author

G. REES CARROLL,
Chairman, Technical Session, Tuesday, October 17, 1933

GROVER A. HUGHES,
Chairman, Welding Engineering Technical Sessions, Thursday, October 19, 1933.

STEPHEN BADLAM, Author

F. D. EGAN,
Chairman, A. I. & S. E. E., Standardization Committee

ITEMS OF INTEREST

Walter Sheldon Tower, whose election as executive secretary of the American Iron and Steel Institute was announced by the directors on September 20, brings to that organization an economic and commercial background which should prove invaluable in the administration of the industry's code of fair competition. In his recent position as manager of commercial research for the Bethlehem Steel Co., Bethlehem, Pa., he took an active part in the preparation of the code for submission to the National Industrial Recovery Administration, and during the brief period it has been in force, he has freely offered his services to the industry as a whole in the interpretation of its complexities.

▲

Carl G. Ohlson has joined the staff of the Aetna-Standard Engineering Co., Youngstown, as vice president in charge of engineering. For the past three years he has been identified with the Morgan Construction Co., Worcester, Mass., and previous to that was with the Youngstown Sheet & Tube Co., Youngstown.

▲

Lewis J. Firth, president and director of the Firth-Sterling Steel Co., McKeesport, Pa., has been elected chairman of the board. He has been a director of the company since it took over the Sterling Steel Co. in 1897, and president for the past 34 years.

▲

Mr. Gilbert L. Yetter, formerly Materials Engineer in the Bureau of Construction and Repair, Navy Department, has been appointed Welding Engineer for the Bureau of Reclamation, Department of the Interior, assigned to the Boulder Canyon Project. Mr. Yetter is supervising the inspection of the fabrication of the welded steel penstocks being manufactured for the project.

▲

W. B. Gillies, vice president in charge of operations of the Youngstown Sheet & Tube Co., has announced the appointment of W. T. Filmer as supervisor of safety for the company's plants in the Youngstown district. Mr. Filmer has had long association with the Youngstown Sheet & Tube Co., and formerly was fire prevention director.

▲

Gordon Fox, who has been associated with the Leningrad staff of Freyn Engineering Company, has returned to the United States, and will resume his connection with the American activities of this company. Mr. Fox has devoted the last five years to engineering work in the Soviet Union for Freyn Engineering Company, during which time this company, in association with the Russian organization, Gipromez, has supervised the development of the steel industry of the Soviet Union, and has directed the design of blast furnaces, open hearth and bessemer works, rolling mills and associated departments for all the major plants of this nation. Mr. Fox was identified with the power and electrical phases of this work. He will present a paper before the Chicago District Section of the A. I. & S. E. E. in November covering his last five years experiences while in Russia.

▲

Mr. Everett Chapman, vice president, in charge of research and engineering, Lukenweld, Inc., Coatesville, Pa., will present a paper, "Welded Design," before the Philadelphia Section of the A. I. & S. E. E., Saturday, November 4th, 1933. This meeting will be held at the Engineers' Club, 1317 Spruce Street, Philadelphia, Pa.

▲

The Pittsburgh Section, American Welding Society will participate in the Association of Iron and Steel Electrical Engineers' Welding Engineering Session, Thursday, October 19th, 1933.

▲

OBITUARIES

James Anson Campbell, board chairman emeritus of the Youngstown Sheet & Tube Co., Youngstown, and prior to his partial retirement two years ago—one of the leading figures of the Mahoning Valley steel industry, died suddenly in his Youngstown home on September 20. He was 79 years of age on September 11, and his death closed a career of more than 40 years in the steel industry. He had been in poor health for many months.

▲

N. L. Mortensen, chief engineer, Cutler-Hammer Inc., died in Milwaukee, September 12. He was born in Denmark and came to America in 1905, joining the Cutler-Hammer Inc., in a minor engineering capacity. He was a member of the A. I. & S. E. E.

N. L. MORTENSEN

and served on several national committees and has presented many valuable papers and discussions before the Association. Mr. Mortensen's death is a great loss and the A. I. & S. E. E. membership extend their sympathies to the associates, friends and family of this prominent electrical engineer.